PROCEEDINGS

Fifty-Ninth Annual Convention

OF THE

American Railway
Bridge & Building Association

1954

Proceedings of the

Fifty-Ninth Annual Convention

of the

American Railway
Bridge & Building
Association

Held at

CHICAGO, ILLINOIS
September 13-15, 1954

Published by the Association
Elise LaChance, Secretary
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J. F. Warrenfells, Seaboard Air Line	Raleigh, N. C.
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PROCEEDINGS

This section contains a running account of the activities during the three-day annual meeting in 1954; brief abstracts of the addresses read to the joint sessions with the Roadmasters' Association; and all of the B. & B. committee reports, printed in full, with abstracts of the discussions that followed their presentation.

The 59th annual convention proved, as usual, to be an outstanding and informative meeting. In addition to the election of officers, and the discussion of routine association business, eight extensive and complete committee reports were presented and discussed.

As in the past the B&B group met, concurrently with, although separately from, the Roadmasters and Maintenance of Way Association. They held their meetings at the Conrad Hilton Hotel on September 13-15.

Considering the fact that no exhibit of manufacturers products was held, attendance at the conventions reached an all-time high. Total registration of the two groups came to 1162 members and guests, including 757 railroad men and 405 representatives of supply companies.

Two Joint Sessions

On Monday morning, September 13, the Bridge & Building and Roadmasters Associations convened in their first joint session. Major addresses at this session were heard from R. P. Hart, chief operating officer, Missouri Pacific, and from E. H. Hallmann, director of personnel, Illinois Central. At the second joint meeting, which was held on Tuesday afternoon, there were also two speakers—M. I. Dunn, vice-president construction and maintenance, Chesapeake & Ohio, and C. P. Fisher, general manager of the Chicago Union Station.

On September 14, the two groups, including members of their families, were entertained at the annual banquet, which was sponsored by the Track Supply Association and the Bridge & Building Supply Association. A total of 1370 persons attended this function.

Separate Sessions of B & B Associations

Lee Mayfield, president of the association, presided over the separate sessions of the B&B Association.

Because of the eight comprehensive committee reports, only a minimum of time was devoted to other matters of business. The eight reports dealt with the following subjects: Adaptation of Water Service Facilities to Dieselization; Cleaning and Painting of Railway Buildings; Trends in Modernization of Freight Stations; Organization for Restoration of Flood Damage; Fireproofing of Timber Bridges; Tunnel Maintenance; Metal Fasteners in Wood Construction; and Inspection, Repair and Replacement of Culverts.

President Mayfield's Remarks

The theme of President Mayfield's address was that "we should all help to sell our railroads to our friends, acquaintances and the public in general." Although "we are supervisors and not traffic men," every railroad man must assume the responsibility of a traffic man. "Certainly we know of someone who, at times, has a shipment of freight to make, or who is planning a trip; so why not prevail on them to use rail facilities."

"Let us constantly inform them of the unfair competition to which the railroads are subjected; how they are hampered by bureaucratic speculation; and how their and our taxes are used to subsidize pampered competitors. This is a fight in which all of us must join in order that our railroads can maintain their rightful places in the transportation industry."

In the election of officers, H. M. Harlow, assistant general supervisor, bridges and buildings, Chesapeake & Ohio, Richmond, Va., was advanced from first vice-president to president; J. A. Jorlett, assistant engineer bridges and buildings, Pennsylvania, New York, was promoted from second vice-president to first vice-president; R. R. Gunderson, bridge and structural engineer, Western Maryland, was moved up from third vice-president to second vice-president; W. H. Huffman, assistant engineer maintenance, Chicago & North Western, Chicago, was promoted from fourth vice-president to third vice-president, and M. H. Dick, editor, Railway Track and Structures, Chicago, was elected fourth vice-president. Directors elected were J. F. Warrenfells (re-elected), assistant division engineer, Seaboard Air Line, Raleigh, N. C.; H. D. Curie, master carpenter, Baltimore & Ohio, Garrett, Ind.; and J. M. Lowry, chief engineer, St. Louis Southwestern, Tyler, Tex.; L. C. Winkelhaus, assistant structural engineer, C&NW, Chicago, was re-elected treasurer.

Looking ahead to the 1955 convention, seven new subjects were chosen, which will form the basis of committee reports to be presented at that meeting. They are: Use of Special Bolts in Structural Steel Work; Heating and Ventilating Diesel Shops; New and Improved Tools for B&B Work; Construction and Maintenance of Roadway Signs; Welding— Application to B&B Work; Modernized B&B and WS Forces; and Modernization of Sanding Facilities.

SECRETARY'S REPORT

of

MEMBERSHIP AS OF SEPTEMBER 15, 1954

Total Active Membership as of September 15, 1953		491	
New Active Members since September 15, 1953		71	
			562
Less—Reported deceased	6		
Resigned account retirement, etc.	9		
Elected to Honorary Membership	1		
Elected to Life Membership	7		
Dropped account did not pay dues	25		48
Total Active Members, September 15, 1954			514
Associate Members as of September 15, 1953		95	
New Associate Members since September 15, 1953		12	
		107	
Less—Reported deceased	2		
Resigned	5		
Dropped account did not pay dues	9	16	
Total Associate Members, September 15, 1954			91
Life Members as of September 15, 1953		73	
Elected to Life Membership		7	
		80	
Less—Reported deceased	9		
Dropped account mail returned	2	11	
Total Life Members, September 15, 1954			69
Honorary Members as of September 15, 1954		7	
Elected to Honorary Membership		1	
Total Honorary Members, September 15, 1954			8
Total Membership (All Classes) September 15, 1954			682

TREASURER'S REPORT

September 1, 1953 to August 31, 1954

Cash Balance—September 1, 1953		$3,420.18
RECEIPTS:		
Dues	$2,838.50	
Advertising (1952 Proceedings)	1,865.00	
Refund from Rdm. & Maint. of Way Assn. for Ladies Luncheon	205.27	
Refund from Cooley's Cupboard account overcharge	60.35	
Sale of 1953 Proceedings - 1 Copy	2.00	4,971.12
Total		$8,391.30
DISBURSEMENTS:		
Salaries	$1,013.20	
Social Security and Withholding Taxes	177.71	
Stationery and Printing	451.34	
Proceedings (1953 issue) including $100.00 to L. Waters, Typist	1,992.16	
Office Supplies	47.50	
New Office Equipment (⅓ of $459.75)	153.25	
Postage	122.13	
Rent and Phone	342.33	
Convention Expense for 1953	1,061.05	
Miscellaneous	115.00	5,475.67
Cash on hand—August 31, 1954		$2,915.63
ACCOUNTS RECEIVABLE:		
Due from Advertisers 1953 Proceedings		1,925.00
Total as of August 31, 1954		$4,840.63

L. C. WINKELHAUS,
Treasurer

APPROVED:

W. H. HUFFMAN,
Auditing Committee

REPORT OF AUDITING COMMITTEE

TO THE PRESIDENT AND MEMBERS OF THE AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION:

Gentlemen:

We, the undersigned members of the Auditing Committee, have examined the books of the Secretary and the Treasurer for the period September 1, 1953, to August 31, 1954, inclusive, and have found them to be correct as of the latter date.

Respectfully submitted,
G. E. MARTIN, *Chairman*
W. H. HUFFMAN, *Auditing Committee*

RESOLUTIONS COMMITTEE:

The American Railway Bridge & Building Association, in convention assembled, recognizing that the special efforts of certain parties should be fittingly acknowledged, does hereby recommend the following resolutions, to wit:

Be it resolved that the appreciation of the officers, members and guests of this Association be expressed to the management and personnel of the Conrad Hilton Hotel for the cooperation and hospitality we have enjoyed.

Be it further resolved that the sincere thanks of the officers and members of this Association be extended to the Simmons-Boardman Publishing Corporation and its representatives. Their assistance and interest have been invaluable.

Be it further resolved that the sincere appreciation and thanks of the officers, members and guests of this Association be extended to the officers and members of the Bridge and Building Supply Men's Association and to the Track Supply Association. Their untiring and devoted support of our Association at the convention and throughout the year is a vital factor in the success of our efforts. The banquet and entertainment is a bright spot in the year.

Be it further resolved that the sincere appreciation and thanks of this association be extended to Mr. R. P. Hart, Chief Operating Officer, Missouri Pacific; to Mr. E. H. Hallmann, Director of Personnel, Illinois Central; to Mr. M. I. Dunn, Vice President, Construction and Maintenance, Chesapeake & Ohio; and to Mr. C. P. Fisher, Operating Officer, Northern Region, Railroad Section, Illinois Civil Defense Agency.

Be it further resolved that the appreciation and thanks of the officers, members and guests of this Association be extended to the management of the Electro-Motive Division of the General Motors Corporation for extending to us an invitation to go through their plant at LaGrange, Ill.

Your Resolutions Committee recommends that these resolves be spread upon the Minutes of the Convention so that they become a part of our Annual Proceedings and that copies of these resolves be forwarded to the parties concerned.

E. R. SCHLAF, *Chairman*
R. R. GUNDERSON
R. E. DOVE, *Resolutions Committee*

REPORT OF NECROLOGY COMMITTEE

TO THE PRESIDENT AND MEMBERS OF THE AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION:

We regret to advise that we have learned of the loss of eighteen (18) members through death during the past year. It is possible that other members have passed away during the year of which we have no information. The following have been reported:

NAME	TITLE-RAILROAD	JOINED	DIED
Active Members			
W. H. Begeman	Supv. B. & B. Missouri Pacific Jefferson City, Mo.	1941	January 10, 1954
John J. Bliss	Gen. B. & B. Fore. Belt Railway of Chicago Chicago, Ill.	1950	October 22, 1953
Wm. R. Burke	Supv. B. & B. Illinois Central Champaign, Ill.	1947	1954
H. S. Hildebrand	Supv. Struct. Pennsylvania Columbus, Ohio	1952	March 25, 1954

Frank L. Lee	Supv. Struct. Pennsylvania Cincinnati, Ohio	1951	1953
Guy E. Martin	Supt. Wtr. Serv. Illinois Central Chicago, Ill. 1951-52 President	1942	January, 1955
C. C. Sims (Ret.)	Asst. Supv. B. & B. Chesapeake & Ohio Hinton, W. Va.	1947	December 25, 1953
Associate Members			
G. H. Bailey	Supt. R. R. Div. Morrison-Knudsen Boise, Idaho	1946	1954
Ralph N. Tracy	Mgr. R. R. Sls. Armco Drainage & Metal Products Denver, Colo.	1946	1953
Life Members			
W. J. Azer (Ret.)	Supv. B. & B. Chicago & North Western Chicago, Illinois	1920	November 4, 1951
W. Buckingham (Ret.)	Br. Fore. Michigan Central Jackson, Mich.	1928	1953
John P. Canty (Ret.)	Asst. to Engr. M. of W. Boston & Maine Melrose, Mass. 1908-09 President	1901	1954
Leland Clapper (Ret.)	Ch. Engr. Duluth, Missabe & Iron Range Duluth, Minn.	1919	November 19, 1953
B. L. Johnson (Ret.)	Gen. Mast. Carp. Great Northern Spokane, Wash.	1919	1953
John L. Talbott (Ret.)	Gen. Fore. B. & B. Santa Fe Pueblo, Colo.	1905	August 23, 1953
L. A. Warren (Ret.)	Supv. B. & B. Southern Pacific Sacramento, Calif.	1929	September 2, 1953
Walter Watson (Ret.)	Supv. B. & B. Elgin, Joliet & Eastern Joliet, Ill.	1930	January 1, 1953
F. W. White (Ret.)	Supv. B. & B. Lehigh Valley Buffalo, N. Y.	1915	December, 1952

We deeply regret the passing of these our fellow members. May we stand a moment in silence to honor these departed members.

Respectfully submitted,
E. R. Schlaf, *Chairman*
M. H. Dick
R. R. Gunderson
Necrology Committee

Memoir

Guy Emerson Martin

Mr. Martin

Guy Emerson Martin, superintendent water service, Illinois Central died on January 13, 1955, after an illness of several months. He is survived by his widow, Mildred Stegar Martin and two children, Mary Bert, 15, and Guy E. Jr., 7.

Mr. Martin was born on December 9, 1898, in Princeton, Ky. He attended the Princeton public schools and the University of Kentucky.

In 1921, Mr. Martin entered the service of the Illinois Central as a water service helper at Princeton. In 1922, he was promoted to water service repairman, and in 1926 was advanced to the position of supervisor of water service on the Gulf & Ship Island. In 1940, he was made supervisor bridges and buildings on the Kentucky division of the Illinois Central. In 1942, he was promoted to superintendent water service with headquarters at Chicago, the position he held at the time of his death.

Mr. Martin joined the American Railway Bridge & Building Association in 1942. He was elected a director in 1945, and became president in 1951. He was also a member of the American Water Works Association.

He joined the American Railway Engineering Association in 1942, and was active in the affairs of that association.

Mr. Martin was kind, human and faithful. His associates will mourn his passing.

Abstracts of addresses by Messrs. Hart, Hallmann, Dunn and Fisher as delivered before the two joint sessions are presented below.

Responsibilities of Supervisors

R. P. Hart, chief operating officer on the Missouri Pacific, was the first speaker at the joint opening session, which was held on Monday morning, September 13. In his address, entitled "Increasing Responsibility of Supervisors on Today's Railroads," Mr. Hart left little doubt that railroad management expects its supervisory personnel to make even greater contributions to railroad progress than it has in the past.

He referred to the improvements in methods and equipment that have made it possible to hold maintenance expenditures to nominal increases, while wages and material costs have been going up sharply.

He went on to say that in the light of reduced income, keener competition and increasing costs, "you must now be more alert than ever before to discover and adopt refinements that will effect still greater economies in the maintenance of our railway facilities.

Mr. Hart urged his listeners to observe the operations of mechanical aids closely "to be sure you are getting full efficiency from them," to "personally study your equipment and become intimately acquainted with it in order to get the best results from its operation."

Work crews should also be kept under observation so that "you can tell whether each workman is consistently performing, hour after hour, a reasonable amount of effective work," and to give the foremen the kind of direction they may need or desire.

Mr. Hart also sees need for being "more cautious than ever about the selection of men" to be sure they are physically fit, for more careful planning in selecting the means to be used in getting men to and from work, and to use the best quality of materials and supplies available."

Employees Are Greatest Asset

The second speaker at the joint opening session was E. H. Hallmann, director of personnel, Illinois Central, whose subject was "Public Relations Depend on Employee Relations." Mr. Hallmann emphasized the fact that employees are a railroad's greatest asset, and that it is the duty of the supervisor to make the most of this asset. He went on to state that, in order to do this, the supervisor must accomplish three things:

"First, we must be more selective in hiring new employees; second, we must do a thorough job of indoctrinating and training employees; and third, we must identify the better than average employees within the ranks and help them achieve what their abilities promise."

Mr. Hallmann went on to say that it is easy for most people to visualize the ideal employee but finding him is another matter.

What we must do is to give "more attention to interviewing, testing and screening applicants for employment if we want to be certain of having personnel who are a credit to our industry. After hiring the right kind of people, our next responsibility is to help them get started in the right path."

Future of Maintenance of Way

During the afternoon of Tuesday, September 14, the two groups held another joint session. The first speaker at this session was M. I. Dunn, vice-president, construction and maintenance, Chesapeake & Ohio, who spoke on "Immediate and Long Range Future of Maintenance of Way." Mr. Dunn expressed the opinion that "the railways will continue to dominate the freight transportation field during the foreseeable future," but that railway passenger train mileage "will no doubt continue to shrink."

For this reason Mr. Dunn feels that in the future "the roadmaster will be more concerned with the safe maintenance of track for high-speed freight trains because we cannot compete for the most desirable freight traffic unless we give fast, dependable and damage-free service." He feels that the accomplishment of this task will be facilitated by "three tried tools," namely mechanization, gang maintenance and programming. To develop the importance of the mechanization tool Mr. Dunn presented figures showing that a "track laborer receives about the same wage today for two hours work as he did for eight hours in 1936." These accelerated wage increases, he said, are the primary reason for the development and adoption of the mechanization tool.

Mr. Dunn then discussed the gang maintenance tool. He described how the C&O, beginning about two years ago, took one division at a time "and commenced doing heavy track maintenance with a few large extra forces equipped with tools and enough men to do the work economically."

Speaking of the programming tool, he declared that a program has to be formulated and followed. He sees this kind of proramming as being something new. "We are no longer firemen rushing from point to point just ahead of trouble. The millions of dollars that have been put into the railroads have, I hope, brought us to a point, where, please heaven, we shall never have to go back to that situation."

In Case of H-Bomb Attack

The second speaker at the afternoon session was C. P. Fisher, general manager of the Chicago Union Station, who spoke in his capacity as operating officer, Northern Region, Railroad Section, Illinois Civil Defense Agency. His subject was the "Effect of the H-Bomb on Track and Structures."

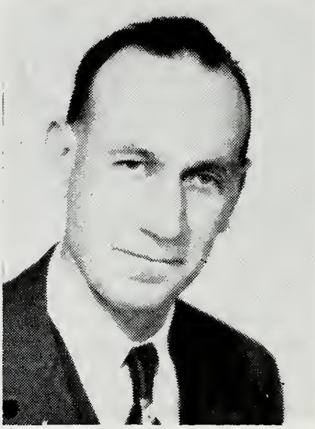
In discussing the possibility of an H-Bomb attack, Mr. Fisher went over the problems that will face the country as a whole, but more particularly railway maintenance-of-way supervisors. He explained that H-bombs are 1000 times more powerful than A-bombs used on Nagasaki and Hiroshima, and that the area of blast is 10 times that of the smaller bomb. The total area of damage may exceed 1,250 square miles.

The responsibility for determining the extent of damage to railroad facilities will be placed on the men responsible for maintenance of tracks and structures. Then decisions must be made as to the areas which can be repaired quickly to return the important lines and facilities to service.

Tunnel Maintenance

Report of Committee

COMMITTEE—**Shirley White**, *Chairman*, gen. b.&b. supv., SP, San Francisco, Cal.; **W. B. Warfield**, *Vice-Chairman*, supv. struc., PRR, Swissvale, Pa.; **E. B. Jones**, *Vice-Chairman*, supv. b.&b., C&O, Clifton Forge, Va.; **J. E. Blake, Jr.**, asst. supv. struct., PRR, Harrisburg, Pa.; **H. A. Bowman**, mast. carp., FtW&D, Wichita Falls, Tex.; **P. D. Burner**, asst. gen. supv. s.&w.e., WP, Oakland, Cal.; **W. W. Gaines**, supv. b.&b., C&O, Huntington, W. Va.; **H. F. Clouett, Jr.**, gen. fore. b.&b., NWP, San Rafael, Cal.; **F. H. Cramer**, br. engr., CB&Q, Chicago; **V. W. Davis**, mgr. r.r. sls., Armco Drainage & Metal Products, Atlanta, Ga.; **H. M. Dick**, supv. struct., PRR, Harrisburg, Pa.; **J. G. Howard**, b.&b. insp., WP, Sacramento, Cal.; **J. D. Ferguson**, supv. b.&b., C&O, Hinton, W. Va.; **M. J. Laurick**, gen. fore. b.&b., PRR, Pittsburgh, Pa.; **C. V. Mero**, contractor, Richmond, Va.; **Raymond Patterson**, reg. vice-pres., Intrusion Prepakt, Chicago; **H. R. Peterson**, ch. engr., NP, St. Paul, Minn.; **E. L. Phillips**, mast. carp., CB&Q, Casper, Wyo.; **H. E. Weatherly**, asst. div. engr., T&NO, El Paso, Tex.; **G. Switzer**, asst. div. engr., WP, Sacramento, Calif.



Shirley White
Chairman

Tunnels are vital structures and have contributed to reducing grades, curves and length of line, and will always be a facility used in the economical development and operation of railroads. Their maintenance is one of the major items of expense to be figured in the yearly budget.

The budget is worked up from the results of inspections which are made quarterly by division inspectors, annually by B&B supervisors and division engineers, and sometimes by the system bridge engineer or his representative. The method of inspection varies on different railroads, but at least one inspection each year of timber lined and unlined tunnels should be made from a scaffold car with adequate lighting and other necessary facilities.

Natural Rock Unlined Tunnels

Natural rock unlined tunnels require scaling, some monthly, some annually, and others go for years without having to be scaled, depending upon the type of rock and the geographic location. The frequency of necessary scaling has decreased considerably with the replacement of steam by diesel power due to the lack of erosion producing blasts from the steam engines.

Scaling is usually done from a 16-ft scaffold car propelled by a heavy track motor car, and by a gang consisting of a foreman and 10 or 12 men, including 2 or 3 men for flag protection. Scaling bars are used to pry rock loose from walls and roof, letting the rock fall on the track ahead of the jumbo. In some cases where considerable material is to be scaled down from the roof of the tunnel, and the cost of work train would be less than rehandling costs, a gondola may be used to catch falling rocks as scaling progresses. When large segments are to be dislodged, it is necessary to protect the track or gondola with timber.

For maximum efficiency and safety the scaling gang should be properly equipped with safety helmets, respirators, goggles and suitable lighting facilities, the type depending on the length of the tunnel and its ventilation.

Under ordinary conditions, in which delays by traffic and flag protection will account for about 50 per cent of the cost, light scaling will run from 50 cents to 80 cents per tunnel-foot for each scaling.

The size of timbers used in lining varies from 12-in by 12-in, 10-in by 14-in to 10-in by 18-in, and 3-in by 12-in laminated in the same various sizes. The three-segment arch seems to be the most popular. However, some roads still retain the five-segment sets and there are still some six-segment arches in use. The spacing of sets varies from one to five feet depending upon the geological formation.

The life of timber in timber-lined tunnels depends on location, climatic conditions and the formation through which the tunnel passes. The average life of cedar and redwood reported by several railroads was from 18 to 25 years, exclusive of breakage, and one railroad reports untreated fir and redwood in service since 1909 with a small portion in service since 1868. However, some of this timber in other locations has failed and had to be replaced within ten years. Reports from railroads using creosote pressure-treated timber show that average life in tunnels is from 25 to 40 years.

The first evidence of failure is usually deterioration of footing blocks, allowing the posts to settle, setting up unequal pressure on joints causing them to fail.

Where there are indications of timber breaking because of heavy pressure and timber is otherwise sound, the life of timber lining may be extended a number of years by reinforcing with helper sets between existing sets when conditions will permit. If packing or blocking behind posts and segment joints has become dislodged or decayed causing distortion of timber sets, but timber is otherwise sound, it is sometimes possible to realign and reblock, using existing timbers. But as a general rule, when indications of distortion are noted, it has already caused crushing and splitting of timbers. Packing and blocking of timber sets at joints should be carefully done and thoroughly checked on inspection, as loss of blocking at these points may cause damage to timbers, necessitating premature renewal of timber sets.

When conditions do not permit or justify reinforcing of existing timber, it is necessary to renew when failure is indicated by breakage, decay, or distortion.

It is sometimes necessary to renew single sets or a few sets at isolated points in a tunnel, but it is generally considered most economical to retimber, out of face, certain sections of a tunnel where indications show extensive repairs required, as there is usually a considerable amount of cutting back to do to obtain proper clearance or regain original alinement.

Renewing timber sets requires gangs of from eight to ten men, using one or more "jumbo" or scaffold cars and power tools. A track power crane is used for handling timbers or a boom is mounted on a jumbo car and the timber handled with a pneumatic hoist.

Various types of equipment are used to remove debris from tunnels. Hydraulically operated portable dump units in one- and two-yard capacity may be obtained which are designed for use on push cars or flat-bed trucks and can be operated by one man. These steel beds can be placed to dump in any direction and are preferable to the dump boxes that require balancing of loads to be dumped manually.

Minor repairs to timber-lined tunnels such as securing loose struts, lagging and blocking, can be done annually and are sometimes done with a gang on the "jumbo" car in connection with the annual tunnel inspection.

Conditions under which timber sets are renewed or replaced are so variable that an average cost is of little value. Costs reported vary from $240 to $750 per set or from $80 to $270 per foot, which for the most part includes some enlarging, realining, relagging and repacking.

The life of tunnel timbers has been prolonged a number of years by replacing timber footings with continuous concrete footings before timber becomes too badly distorted. One method used for placing continuous concrete footing blocks is by supporting tunnel timbers on braces between whalers bolted to tunnel posts and footing blocks outside the track in sections not to exceed 24 ft., while posts are cut off, footing blocks removed and necessary excavating and form work done. Concrete is mixed outside of tunnel and transported to point of use in dump boxes or concrete cars carried on push cars handled by track motor cars. One road reports mounting two small mixers on push cars, which were charged outside, delivered to locations of forms by motor car, and dumped direct into the forms. A gang of 16 to 18 men is used for this work to take full advantage of use of flag protection.

Cost for placing continuous concrete footings without gutters, including flag protection, delays by traffic and falsework to support tunnel timbers varies from $25 per tunnel foot, where traffic is light and tunnel pressure and drainage conditions are favorable, to $60 or more per foot depending on the amount of traffic, heavier pressure and excessive moisture creating a greater drainage problem.

Fire Protection

Fire protection in timber-lined tunnels consists largely in removal of the decayed timbers, keeping refuse from accumulating in tunnel, and certain restrictions on motive power and work equipment standing in tunnels without exhausts from motors being diverted from timber.

Fire barrels are placed at the ends of tunnels, with fire extinguishers spaced throughout. Water lines are also placed in tunnels with frequent hose outlets, and some tunnels are equipped with sprinkling systems.

It is important that grass and brush be kept cleaned away from the vicinity of the timber portals of timber-lined tunnels. This fire hazard has been decreased at many timber-lined tunnels by the installation of concrete portals and a short length of concrete lining at each end.

Steel Lining

An unlined tunnel 3,800 ft in length was lined with 8-in by 8-in by 19-ft 6-in H-beams for posts and three-segment arch of same material, with 4-in by 6-in by 12-ft white-oak lagging backfilled over arch with treated pine cordwood. Steel posts were spaced from 1-ft to 6-ft centers, depending upon condition of rock formation. Rock was used for backfilling of posts. Equipment used for this work was a track "jumbo" car, electric generator, 315-cfm air compressor, paving breakers, rock drills, power picks, and air saws. A 12-man gang completed 16 ft to 24 ft in a 40-hr week at a cost of $322 per tunnel foot. Steel in this tunnel is protected with suitable coatings.

A reprint from *Railway Age* of December 5, 1942, describes installation of metal lining of arch in double-track tunnel 4,716 ft long with 7-gage liner plate channelized to 2-in depth and resting on concrete sidewalls. After installation of the liner plate, cavities behind plate were grouted and protective coating of shotcrete reinforced with wire mesh of 2-in minimum thickness was applied. Work was carried on under traffic on one track by foreman and nine men. There is no cost data available.

One railroad reports brick-lined tunnels in which the brick and mortar were badly deteriorated were relined with ¾-in to 4 ins of shotcrete. Eight sacks of cement were used to 1 cu yd of sand. It was first necessary to clean the old brick linings by sand blasting immediately ahead of the shotcrete work. This lining has been in use for several years and is considered satisfactory. No cost data are available.

Concrete tunnels when cracked and deteriorated have also been repaired with shotcrete. The cracks are first chipped and cleaned out and, where necessary, sand blasting is done on area to be shotcreted. This work requires a gang of from 8 to 12 men, equipped with a cement gun and accessories, air compressor (315 cfm minimum), small concrete mixer for dry-mixing aggregates, scaffold car, and motor car.

Major repairs were made to several earthquake-damaged concrete tunnels by applying from 2 in to 6 in of shotcrete over reinforcing steel. No cost data are available on this type of repairs as it was done by contractor under emergency conditions and with no traffic delays.

Shotcrete has also been used for protecting the roofs of unlined natural rock tunnels from locomotive exhaust blasts.

The shotcrete method was used to apply concrete to a 570-ft rock tunnel after the timber lining had been destroyed by fire. In order to get the tunnel back in operation, it was first scaled and then a light coating of shotcrete ½-in to 2 ins thick was applied. Water, used to extinguish the fire and cool the rock caused excessive spalling which enlarged the tunnel to as much as 22 ft wide and 30 ft high. This permitted a permanent scaffold to be used for shotcrete work and still allow traffic to be resumed.

The tunnel was shotcreted according to AREA specifications of 7 sacks cement, 4 lb sodium chloride and 1 cu yd of sand. Holes ⅝-in in diameter and 3 ins deep were drilled in the rock at 18-in centers, and ½-in deformed reinforcing dowels, with ends slotted for a 2-in wedge, were driven into the holes. The length of the dowels varied from 6 ins to 12 ins, depending upon the condition of the rock face. Twelve-gage 6-in by 6-in wire reinforcing mesh was attached to the dowels and shotcrete applied to a depth of 6 in. In places where the condition of the rock necessitated shotcrete application up to 12 in thick, 1-in vertical and ½-in horizontal deformed reinforcing bars were placed and covered with shotcrete. One feature that had to be watched very closely was the tendency of the shotcrete to build up on the wire and not adhere to the rock. This happens very easily if the wire mesh is not within an inch or two of the rock.

On account of the irregular surface of the arch, roof bolts were used to anchor ledges and protruding sections that did not form a true arch. One-in holes were drilled into the solid rock at points to be anchored, and 1-in diameter roof bolts of proper length, with 6-in threads on one end and the other end slotted 6 in long with a cutting torch to receive a 1-in wedge, were inserted in the holes and driven against the wedge with a power hammer. Washers made from second-hand tie plates were placed on the threaded ends of these bolts. These roof bolts were installed in 1952 and to date have not shown any indication of impending failure.

Repairs by Grouting

The following method was used for grouting cracks .006-in to .125-in wide in a 7,131-ft concrete-lined tunnel built by the Bureau of Reclamation in 1946-50. Seepage from these cracks was causing icing conditions in the tunnel.

Three-eighths-inch pipe flanges with pipe tees and street elbows were attached to the wall of the tunnel over the cracks, at predetermined intervals by means of clamps secured by lead expansion shields set into the wall about 3-in from the cracks to be repaired.

Muriatic acid and fine picks made from broken hacksaw blades were used to thoroughly clean the cracks where pipe flanges were to be placed. A ¼-in fiber reinforced gasket was cemented to the pipe flange to prevent leakage. The pipe flanges were anchored to the wall and allowed to stand for 24 hr so the adhesive could set firmly. The area between the pipe flanges was bush-hammered and plastered with cement paste to seal the surface of the crack.

After the cracks were prepared, a one-cylinder motor, operating a single-action plunger pump capable of producing pressure of 500 psi., was used to force grout into the pipe flanges. The grout pump was equipped with a three-way valve and threaded coupling so a direct hookup could be made into the pipe flange and the flow of grout controlled.

The procedure followed was to start grouting at the bottom flange and continue until there was a return of grout through the flange above. Then the bottom flange was plugged and the next one grouted, continuing the process around the circumference of the tunnel.

The grout mixture used was as follows:

For cracks .005 to .010-in—Equal parts by weight of ultra-fine cement and water.

For cracks .010 to .020-in—One part ultra-fine cement to .8 parts water.

For cracks over .020-in—One part commercial high-early-strength cement to .55 to .75 parts water.

In general, the cracks over .025-in would take about one pound of cement in grout per foot of crack, and the cracks from .010 to .025-in would take about one-half pound of ultra-fine cement in grout per foot of crack. Cracks less than .010-in would not take appreciable amounts of grout or water.

This grouting was about 50 per cent effective, and reduced the ice formation at some cracks to nothing. It was found to be difficult to keep the grout in the cracks until set up on account of the tendency of the seepage water to wash it out.

This was overcome by adding a quick-setting compound to the grout mixture, but this would occasionally cause grout to set up in the pump while clearing for trains. Where a quick-setting admixture is used the amount of materials mixed should be governed to clear the pump and supply hose in time to clear for trains.

Scaffolding for this work consisted of an expandible tower with revolving platform mounted on a small truck with pneumatic tires and small flanged guide wheels, which could be easily and quickly removed from the tunnel and track with all equipment for passage of trains.

Cost to grout 526 lin. ft of cracks, using 154 lb of commercial high-early-strength cement and 307 lb of ultra-fine cement was about $8000.

Repairs to tunnel linings have been done by packing the area to be repaired with graded coarse aggregate and pumping treated mortar into it.

Waterproofing

A recent project covered the waterproofing of a 4,731-ft concrete-lined tunnel, 2,250 ft of which was originally brick-lined. The concrete lining was placed in 1932 by concrete pump and shortly afterwards, numerous leaks developed at construction joints and at several honey-combed areas. In the previously brick-lined portion, parallel cracks developed in the center of the arch.

The joints or cracks where leaks appeared were chipped out to an approximate depth of 4 in by first cutting a 6 in wide trough along the fissure, then "V" chipping the joint or crack to an additional depth of 2 in. Two-inch in diameter by 4-in deep holes were drilled into the joints at intervals of about 4 ft, and short sections of hose were inserted to bleed off the leakage and for grout inserts. The "V" portion of the crack was sealed to within ¼-in of the top of the "V" with shotcrete waterproofing, consisting of one part portland cement, two parts sand, and 25 lb iron mixture per sack of cement.

When the shotcrete waterproofing has set, the "V" was completely filled with an application of ¼-in thick expansion material such as pitch or another fibrated mastic pitch. Bonding coat was applied to all chipped areas before treatment started. The 2-by-6 trough was filled with dense reinforced shotcrete consisting of one part cement, three parts sand and ¼ part iron mixture, which adhered securely to the original sound concrete.

The cracks and joints behind the watertight seal were filled with pressure grout, pumped into the voids through the bleeder hoses. Other areas were chipped out to a minimum depth of 2 ins and treated similar to above.

Relining Tunnels

When timber lining in tunnels requires major repairs or where heavy pressure in timber-lined tunnels and spalling and eroding of unlined tunnels requires excessive maintenance, consideration should be given to installing complete concrete lining, concrete ribs between timber sets, pre-cast concrete sets or steel linings.

The following method was used by one railroad for complete concrete lining: Reinforced 6-in by 6-in steel H-beams, arched to the shape of the tunnel and placed at 2-ft 6-in centers, were used for supports for 1-in plywood forms. Concrete was placed with a concrete pump operated from a flat car designed for the purpose with the concrete mixer and aggregate handled from an adjoining flat car.

Equipment was moved in and out of the tunnel by use of a 40-ton diesel-electric crane equipped with a clamshell for loading aggregates.

Work was done with a gang of 15 to 25 men and the average cost of installation was $309 per tunnel-foot.

The Sacramento Northern Railway, which operates between Oakland, Calif., and Chico, used a pre-cast elliptic rib which was pre-cast in two sections and could be set in place in 30 or 40 min by use of a concrete wedge poured in after the sections were set, making the sets rigid.

This present lining was placed in 1921 at the cost of $108 per tunnel-foot and has held up in excellent condition through ground formation in which a timber lining would have been very difficult to maintain.

It is usually necessary to retimber timber-lined tunnels ahead of concreting to correct distortion and obtain necessary clearances. After retimbering is completed, reinforcing steel is placed for concrete ribs between timber sets or 4-ft sections of continuous concrete lining. Two-inch forms are anchored to tunnel timbers with lag screws through channel, pipe or timber whalers.

When concrete ribs are poured between timber sets, ½ in horizontal reinforcing bars are bent 90-deg about 10 in from the ends and are placed against the timber on each side of rib. When the timber is removed and iron straightened out, it forms a continuous ribbon of horizontal reinforcing steel. Space where timber is removed is then filled with concrete to form a continuous concrete lining. Timber sets can be removed as soon as concrete ribs are set or can be deferred until a later date when deterioration justifies additional expense.

In cases where timber is to be removed after concrete ribs have been poured, a form is placed on one side of concrete rib spaced from tunnel timbers with wedges ¾ in to 2 in to facilitate removal of timber.

Several methods are used for placing concrete in forms. One of the most satisfactory within its working limits of from 600 ft to 1,000 ft from mixing plant to point of use is a concrete machine which pumps concrete through 6-in or 8-in special quick-coupling pipe directly from mixing plant to point of use. Where the concreting location in tunnel is greater than 800 ft from mixing plant or source of mixed concrete additional units can be spaced at 700 to 800 ft intervals where required. Ready-mix concrete where available is usually more economical than setting up equipment and handling aggregates in restricted space under traffic conditions.

Concrete can be hauled from mixing plant to point of use in concrete carts on high-decked push cars where it is dumped into a concrete skip on a scaffold car and hoisted to the top of tunnel and chuted into side forms. A pneumatic concrete gun can be used to place concrete in the arch where it will not flow by gravity from concrete skip. If the pneumatic concrete gun is not available, it is necessary to shovel concrete from a deck on the scaffold car into the top arch segment. The pneumatic concrete gun requires approximately -500--cfm air compressor and if air line is smaller than 3 ins, an air receiver should be used in connection with concrete gun.

The overall cost of concrete lining, including retimbering, ranges from $250 to $450 per tunnel-foot, depending on amount of retimbering necessary, geological formation and traffic delay.

Pouring concrete by rib method is generally found to be more economical than continuous lining.

Because of the wide range of type of construction, geological formations, climate, and degree of traffic conditions under which railway tunnels are maintained, only a portion of the maintenance methods could be handled in this report.

The unanimous recommendations of this committee are as follows:

(1) As new work is done or major repairs are made on tunnels, they be enlarged to a standard clearance.

(2) As a means of prolonging the life of existing timber-lined tunnels, the wood footings under timber sets be replaced with continuous concrete footings before failure of wood footings results in distortion of timbers and consequent failure or breakage.

(3) As major repairs become necessary and a study has first been made to show the opening up or daylighting is not feasible under existing conditions, consideration should be given to lining timber-lined tunnels and the unlined tunnel with concrete, steel or other permanent lining. In view of the greatly increased labor and material costs of maintaining and repairing timber-lined tunnels, this would be one of the most progressive measures that could be taken to prolong the life of tunnels. The additional cost of installation of any of the permanent materials is offset by the reduction in maintenance cost over a period of time and elimination of the ever-present fire hazard in timber-lined tunnels.

(4) Due consideration should be given to preventing seepage of moisture through concrete and brick-lined tunnels by grouting cracks and providing openings through which drainage can flow without saturating local areas of the lining which contribute to icing conditions and subsequent deterioration of concrete and brick.

Discussion

G. Switzer (WP), who sponsored this committee, presided during the discussion period.

T. E. Jackson (SP) said that a record was kept of the cost of lining a tunnel by the shotcrete method where traffic was diverted for three hours each day to one track. The work was slow in the beginning and the cost was $50 a tunnel foot because the lining was made out of face and it required time for the concrete to dry and set. When they changed their method by first building ribs throughout the length of the tunnel and then going back and filling in between the ribs, the cost went down to $9 a tunnel foot.

J. W. N. Mays (PRR) stated that it is a mistake to line a tunnel having seepage without first getting rid of the water at its source as it only results in a poor job. H. O. Adkins (D&RGW) stated that he does not try to seal seepage cracks as he found the water only finds another entry into the tunnel. He inserts a rubber downspout where seepage occurs, which carries the water to the side drains.

Mr. Switzer inquired about the use of anchor bolts in tunnels and W. B. Warfield (PRR) said that they are useful where rock seams prevail and obviate the need to knock the rock down to prevent a later rock fall.

Inspection, Repair and Replacement of Culverts

Report of Committee

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M. D. Carothers
Chairman

An old dictionary defines a culvert as an arched drain of masonry under a road or roadbed. We who have had experience in bridge departments of major railroads in this country know there are many kinds of culverts in use at the present time with the main classifications consisting of stone box culverts, wood box culverts, cast iron pipe, concrete pipe, corrugated metal pipe, stone arch, concrete arch, rail-concrete, reinforced-concrete box, and many others.

Inspection

Inspection of culverts varies considerably on different railroads as to personnel. Generally speaking, however, it is standard practice to have a minimum of two inspections per year, one being made by designated division officers, and the other by a general bridge inspector usually assisted by a qualified B&B carpenter who is familiar with the local conditions. In addition to the above, the section foreman, who normally goes over his territory at least once a day, must keep a constant watchfulness on the culverts, particularly at times of excessive rainfall. He must be able to determine when a culvert needs attention and, when such a condition is found, to make an immediate report to his supervisor. One of the most important functions of the section foreman, in this regard, is to make proper records during times of high water at the various culverts. This information is extremely valuable when and if the time comes to replace the structure.

The division inspection is usually made in the spring of the year in most territories in order to be ahead of vegetation. The general office inspection is normally made in the fall, not only to be after the heavy vegetation period, but also to check what has been accomplished during the past working season and to give the structures a final inspection before winter sets in. Both of these inspections are normally made by lightweight motor car, as this provides the most efficient means of traveling over the territory.

In most instances there is a standard form or book used for taking notes on these inspection trips, with a considerable amount of the information recorded prior to starting. Information referred to includes the culvert number, mile-post location, size, type, length, height of fill, and any other pertinent facts. Current-year maintenance or repair work, and also betterment or replacement projects, are listed in order not to duplicate information regarding conditions that have been already found and are to be corrected during the coming working season. At the time of the actual inspection, besides recording defects noted or necessary repairs, other notations are also made. These should include such items as high-water marks, determined visually or by discussion with the section foreman, new adjacent highway construction and the related openings under the road, other new construction that might affect drainage conditions, such as real estate projects with storm-sewer systems and, in larger size culverts, whether or not the opening is used as a cattle or stock pass.

In order to make a proper and useful inspection, the personnel involved must be acquainted with the various and sundry things to look for. This report will divide the features to be noted into items for specific types of culverts and those that are general for all types. No attempt has been made to list these features in the order of preference or importance.

On stone-box culverts or stone arches, an inspector should note failure of bond between stones, which is indicated by looseness or absence of mortar at joints, and bulging of parts of surface, indicating internal failure; overloading of individual stones, usually found on stone boxes directly under the major impact area, which show up as split or broken stones; disintegration at the water or ground line, usually caused by frost action; surface disintegration of stones, indicated by weathering, spalling, laminating or slicing and breaking out of small parts; and failure of cover stones, settlement cracks, leakage through cover and consequent disintegration of masonry. Particular attention should be made on stone arches to the condition of the head walls and wing walls. Separation cracks should be measured and recorded in order that later inspections can easily decide if additional movement has taken place, after which proper repairs can be recommended.

The inspection made on wood-box culverts is similar to inspection of any other type of timber structure, that is, an inspection bar is used to test the timber. The most likely decay areas are those subject to alternate dry and wet cycles, such as lower wall timbers, transverse sills, and the top face of the cover timbers. The inspection bar should, of course, be used sparingly on treated timber in order not to deface or mark unnecessarily. Rigid inspection on this type of culvert is extremely important as failure under traffic could mean a serious and expensive derailment.

On rigid sectional pipe culverts, such as cast-iron pipe and concrete pipe, inspection should include checking for settlement and cracking or pulling apart at the joints. Cracking can sometimes be detected by noting a distortion in the shape of the pipe. Settlement is normally under the track area and can be easily detected by standing water or by sighting along the flow line. Pulled-apart joints are readily discernible at the ends and usually can be noticed farther in by detecting deposits of dirt or embankment which have dropped through the open crack above.

In flexible-pipe culverts, such as corrugated metal pipe, an inspector should look for signs of failure as indicated by shape distortion, sagging due to settlement, and the condition of the invert. This last feature is quite important as water draining over or through certain types of soils develops chemical characteristics which affect the material condition of the pipe, normally in the invert section. The inspection should cover the extent of pitting, abrasion, and loss of metal.

On all types of concrete culverts, which includes concrete box, concrete arch, rail concrete and others, inspection should include, among other items, the condition of the concrete. The inspector should check weathering and disintegration resulting from improperly proportioned materials indicated by a porous condition; poor placement methods, indicated by laitance spots or seams; surface spalling due to freezing; seepage through concrete indicated by crystalline efflorescense on the surface or by discoloration from chemical action. General items of importance and interest for all types of culverts cover such items as scour, whether clean and free of debris, need of paving, apron walls, curtain walls, etc., to prevent and control undermining. A large number of culverts have failed prematurely, not because of their structural or material defects but rather because of improper application and lack of additional construction features such as paved aprons or spillways which have not been provided.

Repairs

The above paragraphs have been directed exclusively to the inspection of culverts, that is, who makes the inspection, how often, form of reporting, and what to look for. The following paragraphs will deal with methods of repairing different types of defects found in the inspection.

On stone-box culverts or stone arches, the normal type of repairs covers pointing and replacement of disintegrated stones. Before filling joints or replacing poor stones with proper mortar or concrete mixture, all joints should be carefully chipped or raked out to depth of at least three inches and cleaned thoroughly with dry air and water under pressure if available. It is very important that the stones and joints in the area to be repaired are kept wet at the time mortar is applied in order to effect a good bond. On larger structures such as concrete arches, disintegration at the water line or at the base of the barrel may have reached such a state that an entire new concrete bench wall is required. Care should be taken to see that a good bond will exist, using steel dowels and sufficient reinforcing to assure a good finished product. Tipped and undermined wingwalls often require a major undertaking to obtain satisfactory results. This is normally done by excavating under the portion of wing wall affected, erecting necessary forms and pouring a proper concrete mix, making sure that it is properly distributed under the masonry to insure a satisfactory job.

Practically all B&B forces are very familiar with this type of repair work and therefore are well qualified to make repairs of this nature in an efficient and well-organized manner.

In wood box culverts, when repairs are in order rather than replacement, treated timber should be used if a major portion or the entire structure is renewed, which will materially increase the life of the culvert. There are no particular instructions required in this work; however, the program should be well planned to eliminate train delay as it is usually necessary to open the fill to make the timber replacements.

On rigid sectional pipe, namely cast iron pipe or concrete pipe, repairs usually consist of closing open joints. Other types of failures in such culverts normally require replacement. This type of culvert can be jacked together and then secured in proper position by placing cables equipped with hooks at each end and supplied with a turnbuckle. Other methods utilize a steel bar hooked into holes drilled in abutting sections. Another, and perhaps the most economical method, is to install inside expansion bands made of corrugated metal. These are manufactured in all standard pipe diameters and have proven very satisfactory.

Monolithic concrete arches or boxes are repaired in the same way as stone arches or boxes, at least insofar as minor repairs are concerned. When major spalling or disintegration has occurred the shotcrete method has considerable merit. In these cases the entire surface is relined with the thickness dependent upon the conditions. The new material is normally applied over wire-reinforcing mesh. A condition to watch carefully when applying concrete in this manner, is to make sure it does not build up on the reinforcing wire, leaving a void adjacent to the old structure.

Replacement

Replacement rather than repair of culverts is nothing more than economics. If replacement can be provided as cheaply as making repairs and the replacement would give as long as or longer useful service life, there should not be much question as to the procedure to be followed. However, there are many conditions which must be investigated thoroughly before any culvert is replaced. Among the important factors is a field survey to accurately determine drainage area. This survey should be supplemented by high-water data, washout information, and rainfall and watershed characteristics, which are among the most important. From this information the correct size of opening can be determined and the project then can be carried to conclusion.

If sufficient cross-sectional area can be obtained by installation of a corrugated pipe within the existing culvert, it is recommended this practice be followed as it is usually the most economical. After the new pipe has been properly placed and sections secured, the void between the old and the new structure is filled with sand or other suitable material and then sealed at the extreme ends.

At locations where the existing culvert is too small or has failed to such an extent that it is not possible to insert the replacement pipe, the jacking method has been used successfully and can be recommended for pipes up to 72 in. in diameter. For small-diameter pipes earth augers have been used successfully. Pipe having a diameter of 36 in. is the minimum size in which a man can excavate inside with normal efficiency. Equipment required consists of jacks, short-handled shovels, picks, ropes, and wheel barrows or boxes, together with timber to construct bearing frame, jacking support, and guide timbers.

The site is cleared to provide working space, and an approach trench is dug at the toe of the slope, of such depth at the forward end as to form a vertical face about a foot higher than the diameter of the pipe. As the pipe is jacked into the embankment, workmen inside the pipe excavate ahead with short-handled shovels or other suitable equipment. Jacking is suspended when the rear of the pipe is about a foot from the face of the trench, the next section is then placed in position, riveted to the section already jacked, and the process continued until completed. The old structure is then filled and the ends sealed with concrete plugs.

If larger areas are required than described above, a new opening can be tunneled through the fill using heavy galvanized liner plates up to 15 ft. in diameter. These structures may be asphalt coated and paved in the field.

The discussion on replacement methods has been more or less confined to the smaller replacement projects. On old stone arch and concrete structures that are showing signs of fatigue and will soon require major repairs, it is possible to reline with corrugated metal having a rather heavy gauge depending, of course, on the size of the arch involved. The method normally used involves the construction of a footing or abutment for the arch plates, either by notching the side walls of the existing structures, if they are in sound condition, or by pouring a new reinforced concrete footing along each headwall. The arch is then constructed in place if there is sufficient clearance, or erected at a lower level and jacked up into place, or erected outside the old structure and jacked forward into place. Filling or grouting between the old and the new structure is essential to eliminate possibility of any further failure of the old structure.

The above described methods of culvert and arch replacement projects are the popular methods employed by a majority of the railroads in this country. The jacked-in and tunneled-in culverts are installed in most instances without slow orders due to the fact that the embankment or fill is undisturbed.

In conclusion, the committee assigned to this subject desires it understood that this report is purely informative and does not, of necessity, warrant the applications described as the only or best means of carrying out the three major classifications of inspection, repair, and replacement of culverts. Under inspection, perhaps it can be concluded that the actual persons making the inspection, the form of the reports to be made, and the number of inspections to be conducted annually are matters of choice for each railway system, but the one major issue concerns the safe passage of all trains. If this has been accomplished year in and year out, the ultimate has been fulfilled. Continuing, there are probably as many ways to repair or replace culverts of certain types as there are B&B supervisors. Because of obvious reasons, the committee has only touched lightly on some of the methods known to its members, and sincerely hopes the discussion to follow will bring forth many ideas that will be of definite benefit.

Discussion

W. H. Huffman (C&NW), who was the sponsor of this report, presided during the discussion period.

H. O. Adkins (D&RGW) remarked that he preferred to tunnel with liner plates, when installing a culvert in a long fill, rather than jack pipe sections through because the pipe often gets stuck when jacking.

V. D. Rasessler (IC) questioned the use of inside expansion bands that were mentioned in the report for repairing joints that had pulled apart. Mr. Huffman reported that the bands worked very well with cast-iron and concrete pipes and they eliminated a great deal of the more expensive jacking. H. D. Curie (B&O) stated that he had also found this to be true.

E. E. Cash (Camus Prairie) stated that, after jacking opened joints together again, he had used iron bands recovered from dismantled water tanks to tie them together.

W. H. Pryor (SL-SF) thought that opened joints should be jacked together rather than use the bands, but F. T. Teske (Soo Line) stated that his road used the bands with good results. The bands were made in the railroad shops and were so designed that they would fit oval or round pipes and would bolt to the pipe sections.

Metal Fasteners in Wood Construction

Report of Committee

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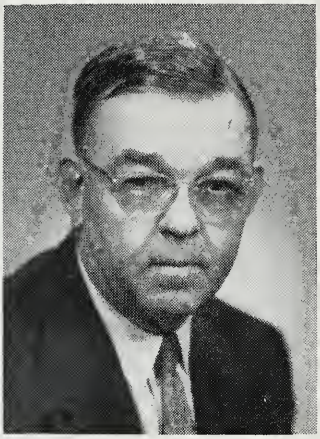

G. W. Benson
Chairman

In the earlier decades of bridge and building construction on the North American continent the use of metal fasteners was comparatively small, probably due to the abundant supply of good structural timber and low-cost labor. At the present time the supply of good structural timbers is somewhat limited and the labor costs per unit of placement are much higher. We now have machine production of many types of metal fasteners available at reasonable cost and their use tends to supplement the restricted supply of structural timbers.

For many years special fastenings were hand forged of wrought iron, whereas now mass production has provided an economical supply of many types of fastenings. Some of the more extensively used timber connectors, such as split rings, toothed rings, shear plates and spiked grids were acquired from Europe and introduced into the United States under patent in 1933 and later impoved in design.

The old type cut nail is again being manufactured and it is proving very useful because of its holding power as compared to the common wire nail. It has been used successfully in fastening wood members to concrete and masonry.

The more ordinary fasteners, such as machine bolts, drift bolts of various types, boat spikes, many types of washers and common nails, continue to be used. Additionally, we now have in use split rings, toothed rings, spiked grids, clamping plates, shear plates, framing anchors, segmental washers, double-grip spikes, drive dowels, washer-head timber drive spikes, ring shank and notch nails, improved lags, hook bolts of various types and many special fastenings developed by various companies to meet special conditions.

There are two noticeable trends in the use of hardware: (1) Galvanized fastenings are gaining in preference over black iron (although one national distributor states that only 5 per cent of their product is now sold as coated); and (2) there is a preference for single-piece fasteners such as drive spikes and lag screws with head and washer forged of one piece. Each type of connector has certain advantages for its particular use, both in convenience and cost.

A brief description of each type of fastener will be made in connection with its application.

Decks of Steel Bridge Spans

The ties are held to a steel stringer or top of girder by hook bolts of various types. One road uses a special lug with machine bolts and washer nuts; spring clips have been used with one end of clip resting on bottom of flange and the other on a tie. These have not been too satisfactory. The most widely used is one having a hook on the bottom end designed to develop full strength of the bolt without bending, with four fins to prevent the bolt turning when forced into the tie and with washer nut with nail hole providing a simple means for preventing the nut from loosening. A coated or galvanized nail is recommended.

The methods of fastening the guard rail to the tie vary from the common machine bolt with a cast-iron OG washer on each end to a special-purpose bolt with an apron head at the top, fins near the top to prevent turning and a washer nut. Also available are washer-head timber drive spikes which are installed in a prebored hole either with spike mauls or pneumatic spike drivers. Wrenches are not used for installation but are used for removal. The manufacturer recommends that all the threaded portion (the holding power) be in the bottom timber and only the smooth shank in the top timber. This is said to place little direct thrust on the threads and does not disturb the holding power of the spike. With the threads in the bottom portion a tight fit can be secured; you cannot over-drive or overturn. These are widely used for installation of highway crossing plank, either countersunk or with protruding bead. They have a definite advantage in salvage and reuse. A countersunk head is being developed for this spike which can be driven flush. Salvage of these will be more difficult.

Installations of clamping plates between the ties and guard rail have been reported. Clamping plates are steel fasteners which are seated between ties and guard timbers. The flat type, which has teeth projecting at right angles from both sides of the plate, is used where ties are not evenly sized, while the flange type, which has teeth projecting from only one side but has flanges at the ends exactly 8-in. apart, is used for evenly sized ties. Using clamping plates, it is not necessary to bore the guard rail at each tie. Bolts or drive spikes are used at every fourth tie with clamping plate on each tie. Fewer holes are bored and no dapping is required. Ties thus fastened do not bunch. A wrought-iron bar, with previously drilled holes, is available for use with lag bolts or drive spikes. The simplest method is the use of a 5-in. by 8-in. S1S timber with ¾-in. by 10-in. lag bolts applied with a power wrench in predrilled hole.

Ballast-Deck Bridges

Construction of these bridges generally follows the AREA recommendations. One road reports the use of button-head drifts; another of plain dowels; most use the countersunk head which can be driven flush. The washer plate between ballast retainer and floor is replaced on some roads with a special small casting. Others do not use the brace plate except on curved trestles, depending on bolts through the ballast retainer (guard rail) floor and outside stringer. This has proven entirely satisfactory. One road reports the use of anchor angles which hold caps to piles. The use of timber connectors is increasing both in construction and maintenance. Many installations of single-curve spike grids between braces and piles, and clamping plates between braces and caps or square posts and caps, are reported both in new construction and maintenance. Flat grids can be used in place of clamping plates.

Spiked grids are made of cast or malleable iron, and are available in 3¼-in circular form or in 4½-in flat or single-curve type. Circular or flat grids are used between two sawn faces, while the single curve grids are used between the curved surface of the pile and the flat surface of the brace. This distributes loads over larger area and minimizes the bolt-hole enlargement in trestle piling and bracing. Grids are forced into the adjacent faces of adjoining members with high strength rods, or by use of jacks. Trestles on which grids have been installed retain more rigidity than those where only bolts are used. The research center of the AAR is now conducting tests on trestle joints and in their annual report they state: "The use of mechanical fasteners when used with a bolt increases the strength of the joint considerably."

In AREA bulletin 510 there are shown load curves for connections between piles and sway braces. The load at proportional limit of a ¾-in bolted joint with a 3-in by 8-in sway brace is 2500 lb, while the load at proportional limit of ¾-in bolt with spiked grid is 4700 lb. The strength and stiffness of the grid joint is attested by the fact that many roads have used this joint for their trestles and in one case its use was responsible for the removal of a slow order on a long trestle over the Mississippi river. Spike grids are shown in the AREA's recommended practices for 4, 5 and 6—pile and post bents on page 7-4-5, 7-4-6 and 7-4-7 of its manual.

The Santa Fe uses split rings for strengthening the laminations of bridge stringers and caps by addition of new pieces fastened to existing one's (see 1951 B&B Association proceedings, page 51). The B&O uses split rings for fastening super-elevation blocks to caps.

The method of fastening guard rails has been discussed under steel bridge decks and that of fastening braces under the material covering ballast decks. The most interesting development has been the use of the stay rod for fastening the deck to the cap. This is shown in detail on page 7-4-3 of the AREA Manual. A recent development has been the use of lags on each side of the cap instead of a through bolt as shown. These are used in both butt-joint and lap-chord construction and eliminate a vertical hole through the stringers. An interesting use of a clamping plate is made by the Central of Georgia in laminating bridge caps for open-deck trestles. This is fully described on page 36 of the 1951 B&B Association proceedings. About half of the caps used by this company for main-line replacements are now made by this method.

Overhead Highway Bridges

The big problem with timber overhead highway bridges with timber floors is to keep the floor nailed down. The preponderance of reports from the committee favors the use of the double-grip spike. This has a countersunk head which can be driven flush with the wearing surface. It is used in any of the hard woods preferably with a prebored hole, particularly at joints. The big disadvantage to this type of fastening is that it cannot be salvaged, neither can the flooring in which it is used. Some use has been made of composite construction, using a laminated wood subfloor with concrete surface and a thin trapezoidal steel plate to develop shear between timber and concrete.

The Milwaukee built one of these bridges at Savanna, Ill., and reports satisfactory use, but high installation cost. This is fully described in "Wood Preserving News" for October 1946. Other installations of this type are described by "Wood Preserving News" in January 1948, February and October 1951, and January 1954, the latter being of composite construction and located at Clemson, S. C., over the Southern.

Timber connectors provide a much needed accessory for large clear-span timber trusses used in warehouses, shops, freighthouses, car repair sheds, transfer platforms and other structures.

Probably the most widely used of all timber connectors are split rings. Their application in the fabrication of timber trusses has made possible the utilization of smaller section chord and web members than could formerly be used because of the reduced number of bolts required per connection. Metal rings are placed in pre-cut grooves in the adjacent faces of adjoining structural members. Bolts are inserted to keep the faces in contact and are not used primarily for carrying loads. Split rings are made in three sizes, namely 2¼-in, 4-in and 6-in diameters. The most efficient rings are tapered from the center of the outside edges and provide a tight fit when placed in grooves that have a conforming cross section. This type ring also affords easy installation since the smallest section of metal is inserted into the widest portion of the groove. As the ring is installed it tightens automatically with a wedge action.

Toothed rings are used in the same way as split rings except they are forced into the faces of adjacent members and hence are not suitable for prefabrication. Toothed rings are corrugated metal strips with pointed teeth which are formed into a circle and welded. They do not carry as much load as a split ring but require no pre-cut groove. These rings are forced in with bolts or high strength rods and ball bearing washers. After they are seated rods are removed and bolts placed and joints tightened.

Shear plates are placed in pre-cut grooves as are split rings, but they are completely imbedded in one member so that they are flush with the face of the timber. They may be used in pairs back-to-back to form wood-to-wood connections or singly for wood-to-steel connections. This will effect a much greater shear value in bolted connections and reduce the number of bolts required per joint. The shear plate is used for fastening columns to foundations with angles or steel straps to transfer loads from columns to the foundation. In trusses the shear plate is used to connect wood members to steel gusset plates at highly stressed joints.

In 1945 the Chesapeake and Ohio rebuilt a merchandise pier, using frame construction. The roof trusses are 86 ft long with 3-in by 12-in top and bottom chords. The interior width of the building is 172 ft and two trusses supported on a common post at the center span the width of the building. These trusses are assembled with split-ring connectors and satisfactory service is being obtained from them.

The use of greenheart and mora for flooring in areas subject to heavy wear is increasing. All reports that the committee has received covering the use of this timber show that the double-grip spike in a prebored hole is used as a fastener.

Framing anchors which eliminate the uncertainty of toe nailing have recently been introduced. Developing their strength through nails acting in shear, these framing anchors are light, strong, economical and easy to install with no special tools or equipment. Some of the uses for these anchors include the fastening of rafters to plates, joists to headers, joists to trusses, girts to posts, connections around rough openings, and hip and dormer roof construction. These framing anchors are made of 18-gauge zinc-coated steel and the nails are a drive fit through the punched holes which provide rigidity as well as strength. For the convenience of builders, anchors are made in three types with right and left for each type. With this variety of shapes there are few places in light frame construction where the anchors are not advantageous.

The use of helix drive nails, ring-neck nails, notch nails, etc., is recommended for permanent construction only. It will be found to advantage to use the common wire nail for temporary construction as the salvage is greater and more easily recovered. Where exposed to weather, such as in siding, nails should be copper, galvanized or coated. As previously mentioned the coated or cut nail will provide greater holding power.

Docks and Wharves

The C&O reports use during last 15 years of approximately one-half million feet of 2-in and 3-in greenheart and mora planking for pier decking. The only satisfactory means of anchoring is the double-grip screw spike. After trying several other types of fastening in 4-in gum, which was formerly used, the double-grip spike was the only one found satisfactory. The C&NW reports a test installation of greenheart in ore pocket at its Escanaba docks. This, as well as the maple floors in other pockets, is fastened with double-grip spikes driven in pre-bored holes.

The C&O has made extensive use of spike grid connectors with application of bracing on both frame and pile bents at docks. The member reporting this use states that it is very difficult to actually determine advantages and for that reason cannot definitely justify the installation cost. (See AAR report on test of grids.)

The committee received only one progress report on test installations of special fasteners. This covered the segmental washer which is intended to take up slack between bolt and washer and can be used without removal of the nut.

One road reports an installation of preframed crossing mats with ¾-in by 12-in washer lag bolts for use on heavy-traffic highway crossings. Some difficulty was encountered in first installations by tendency of bolt head to turn in the chuck of the power wrench. This has since been corrected by making the nut slightly heavier. Other roads use single plank each side of the running rail, held down with double-grip spikes, washer-head drive timber spikes, drive spikes or washer-head lag bolts.

Two roads report the use of a special 45-deg. washer for use in connections of braces to posts. One is cast with a square section, the other with a cylindrical section. This gives full bearing for the bolt squarely through the post.

It is hoped that the research center of the AAR can test more of the fasteners as they become available and report their findings to the member roads.

Discussion

W. H. Bunge (MP), who sponsored this committee and presided during the discussion period, commented on his surprise at the small percentage of coated hardware that the report showed as being used by railroads in brine-drippings territory. A. R. Harris (C&NW) said that he tried an experiment by using galvanized hardware on one side of a bridge deck and uncoated on the other. After 13 years of service, he said, the galvanized hardware was still in good condition and the uncoated had rusted away.

C. Elliott (CofNJ) stated that at places where he had noticed common nails working out of planks from traffic vibrations, he had substituted drive spikes. Mr. Harris said that, where lag screws loosened under traffic, he used drive spikes instead.

Cleaning and Painting of Railroad Buildings

Report of Committee

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W. L. Short
Chairman

Paint is an expendable material used to protect or decorate another material more costly to replace. The best paint for any application is usually the one which will give optimum service for the longest period of time. Eventual failure is inevitable, but rapid deterioration is undesirable and can be prevented by careful observance of sound painting practice.

The primary requirements for satisfactory paint service are:

(1) Design and construction defects should be corrected.

(2) Surface cleaning should be adequate for the paint used.

(3) Paint should be compatible with the surface material.

(4) Paint should resist deterioration caused by the environment.

(5) Paint systems chosen should be suitable for the service.

(6) Application should be in accordance with good practice.

(7) Preventive maintenance is essential to low annual costs.

Design and Construction Defects

Paint failures often result from defects in design or construction. Poor design may prevent access for complete painting. Depressions in outer surfaces restrict drainage; pockets collect debris, which when wetted by rain or dew, accelerates deterioration. Construction features occasionally trap gases which may attack paint and metal surfaces. Inadequate ventilation may permit moisture to condense. Dissimilar metals in contact may expedite destruction of coatings as well as the base metal by galvanic corrosion. Damage or defects in roofs, flashings, conductors, siding, etc., may allow water to enter and cause structural deterioration as well as premature paint failures. Buildings should be checked carefully and such defects corrected before painting.

Surface Cleaning

No "magic paint" exists that eliminates necessity for clean surfaces. Paints fail rapidly if applied to a surface not properly prepared. Proper surface cleaning demands absence of material not firmly adhered or that will not adhere during the potential life of the paint; also, that no chemicals remain which may react unfavorably. The surface preparation must never be chosen at random. The supervisor should know what contaminants are present and the amount of contamination that can be tolerated by the paint in the particular service.

Solvent cleaning can be used to remove contaminants such as oil, grease, soil, soot, salts and soaps from most surfaces. The surface is soaked, dipped, or scrubbed with a rag, sponge, or brush wetted in a suitable solvent such as highflash naphtha, mineral spirits, chlorinated hydrocarbons, water, etc. The solvent dilutes the contaminants and they are carried away by the solvent draining from the surface. A large amount of solvent is necessary so that the contaminants will be thoroughly rinsed from the surface. If insufficient solvent is used, the contaminated solvent will leave a film on the surface after evaporation. Adequate precautions for health and safety are required since the fumes from many solvents are toxic or flammable.

Alkaline cleaning is generally more efficient, less hazardous, and cheaper than using solvents. The cleaning action is aided by detergency or saponification. A solution of water and alkaline cleaning compound is applied to the surface. It is generally preferable to use proprietary compounds; however, a solution of 2 oz. of tri-sodium phosphate and an equal amount of soap or a detergent per gallon of water will suffice for cleaning painted surfaces. The solution is best used hot, but can be used cold if the concentration is increased. Thorough rinsing is necessary, for residual alkali will react with paint and destroy adhesion. Some water supplies are sufficiently alkaline to cause such reaction, making a dilute, beneficial chromic or phosphoric acid treatment necessary.

Steam cleaning is often effective and economical, particularly in conjunction with alkaline cleaners. When old coatings are not badly deteriorated or when mildew, oil, grease, soil or grime must be removed from concrete, masonry and metal surfaces, steam cleaning with suitable detergents is a fast and labor-saving method. Typical equipment consists of a small flash-type boiler, a low pressure atomizing burner, a small tank in which the detergents are mixed and injected into the steam line, and a pump to supply water under pressure. Hot water is supplied to the nozzle of a gun at a temperature of approximately 350 deg. F and at pressures as high as 150 to 200 psi. Water consumption is usually 200 to 300 gal per nozzle hour. Some units supply steam rather than hot water. If scouring is desirable, a fan-shaped nozzle can be fitted with a suitable fiber brush.

Acid cleaning is used to remove oil, grease, soil, light rust, and other contaminants. A solution of orthophosphoric acid, a grease solvent, a wetting agent, and usually a detergent are included in typical cold or hot cleaners for ferrous metals. The acid etches the metal surface and leaves a thin film of iron phosphate which offers an excellent base for paint. Other acids may be used, depending on the surface material. Dilute solutions of muriatic acid are used for cleaning, masonry and concrete surfaces. This acid cleaning is often used for new plaster, mortar, cement, or concrete surfaces to be painted.

Paint and varnish removers are available in several types. The choice for a particular job depends on such considerations as kind and amount of paint to be removed, interior or exterior environment, fire and safety hazards, etc. Strong alkaline compounds should not be used on non-ferrous metals; they also darken wood and unless entirely removed or neutralized will destroy subsequently applied paint. A number of solvent type removers are available. They are usually a mixture of powerful solvents and contain some thickening agent, such as a wax, to prevent rapid run-off and evaporation. The thickening agent must be removed from the surface before subsequent painting, and the volatile constituents are often toxic or flammable.

Hand cleaning, the oldest and most widely used surface preparation, is adaptable to all types of surfaces and is effective for the less severe environments, but adequate tools employed in the hands of diligent workmen are necessary. Tools include dusters, brooms, wire brushes, knives, light and heavy scrapers, chipping hammers, and abrasive paper.

Power tools may prove economical on large surfaces; their use is often more costly, but a better degree of surface cleanliness results. Pneumatic or electric tools include chipping hamers, scalers, wire brushes, sanders, and grinders.

Blast cleaning is a very effective method of cleaning structural steel, concrete, brick, or any surface that will resist damage from impingement of the abrasive. Cleaning is generally carried out with dry abrasive but can be adapted to wet operations to eliminate dust hazard. For special cases, where dust cannot be tolerated, closed recirculating units are available. The economy of blast cleaning depends largely on selection of the proper abrasive for the particular cleaning problem involved. A wide variety of abrasives are available, ranging from crushed steel grit to ground corn cobs. However, inability to reclaim spent abrasive in the field generally limits the choice to sand or other low-cost abrasive. Care must be taken that the blast pattern produced is compatible with good paint performance.

Paint burning is used to soften or carbonize old paints so that they may be easily scraped or brushed off. Equipment consists of a variety of blow torches varying from gasoline types to specially designed torches operated on bottled gases. Fumes from certain pigments used in paints may be toxic; adequate precaution must be taken against hazards associated with open flames. Flame cleaning, a surface preparation method based on special torches using oxygen and acetylene, is sometimes employed before painting structural steel, but the gases used to produce the intensely hot flame are expensive. The same equipment may be used for removing old paint and rust, but the technique must be altered.

Surface Compatibility

Paint should be selected on the basis of good compatibility with the surface. Surfaces can usually be classed as neutral or alkaline. Cement, plaster, and similar lime-containing building materials are alkaline when applied, but lose surface alkalinity on long exposure to air. If painted while fresh or "raw," alkali-resistant synthetic resin paints (either solvent or emulsion type), or cement base paints, must be used. Damp surfaces are incompatible with most paints. Water permeating concrete, plaster, etc., is usually alkaline and causes loss of adhesion of conventional paints.

New galvanized metal is not compatible with any paints except zinc dust paints, making pre-treatment essential if other paints are to be used. Rust is incompatible with synthetic resin paints, and linseed or fish oil vehicles are generally required. Porous surfaces, such as wood, are incompatible with synthetic resin paints of relative impermeability to water, unless vapor barriers are installed to prevent blistering of paint by water passing through the substrate. Difficulties are also encountered when hard topcoats are applied over soft undercoats, when solvents in subsequent coats are sufficiently powerful to soften or "lift" undercoats, or when resins are vastly different and do not adhere.

Resistance to Environment

Paints must resist deterioration caused by the environment. Ultraviolet light and weather are the most commonly encountered deteriorating influences. Clear varnishes and lacquer fail comparatively fast outdoors because they do not have as great resistance to ultraviolet light as pigmented paints. Bituminous cutbacks may require topcoating with bituminous emulsions to prevent alligatoring. Pigments and paint vehicles must be resistant to gases and fumes found in railroad environments. White lead will blacken when exposed to hydrogen sulfide; zinc will deteriorate faster in industrial atmospheres than in rural atmospheres. Oil paints will not stand prolonged exposure to brine drippings. High humidity and condensation rapidly deteriorate straight oil base paints. High temperature decomposes every type of paint vehicle, but resistance to heat varies. Floor paints must be designed to resist great abrasion. Paint may be attacked by fungi in damp warm environments, unless formulated to resist such destruction.

Choice of Paints

Paints consist of pigment and vehicle; the vehicle contains non-volatile solids and volatile thinners. Varnishes, bituminous cutbacks, emulsions, and cementiferous coatings are often included in the paint category. Paints are broadly classified as being of the drying oil, oleoresinous, lacquer, emulsion, or water types. Coal tar or asphalt cutbacks, vinyls, chlorinated rubbers, shellac, etc., are lacquer type paints and dry by evaporation of solvent; drying oil and oleoresinous paints form a solid film by reaction with oxygen upon exposure. The non-volatile substance in the vehicle may be drying oil, resin, bituminous material, glue, casein, cement or a mixture of these substances.

Pigments are added to reduce the rate of moisture penetration, protect the film from ultraviolet light and the environment, hide the surface, provide color, inhibit the corrosive effects of moisture and oxygen on metal surfaces, increase the body of the film so it may be applied thicker, improve storage properties, control chalking so as to make the film self-cleaning, and for other reasons. Substances added for special purposes are driers, wetting aids, stabilizers, anti-flooding agents, anti-skinning agents, anti-livering agents, and fungicides. Paints are also formulated for special purposes; examples are fire-retardant coatings, anti-sweat coatings, anti-fouling coatings, etc.

Exterior wood surfaces, whether new or old, require cleaning and careful preparation before painting. Rough places should be made smooth by planing or sanding. Damaged or deteriorated wood should be replaced, loose knots removed, and the holes carefully fitted with wooden plugs. Surface resin should be removed from knots and resin pockets by scraping, burning, or solvent wiping. Customary practice, such as sealing with shellac, aluminum paint, or vinyl-butyral resin sealer, may be followed. Old paint that is wrinkled, checked, cracked or flaking should be removed. Where defective areas are not large it may be possible to restore the film by spot painting. When damage has occurred because of moisture, the source of moisture should be eliminated before repainting. Wood must be relatively dry when painted; instruments are available for measuring moisture content.

Bare wood, whether new or old, requires priming. Suitable paint for priming contains an extra amount of oil so as to saturate the surface. This is necessary to avoid upsetting the correct pigment-vehicle ratio in the dry film. After priming, nail holes and small defects should be filled with putty. Large defects and any openings around windows and doors should be filled with caulking compound.

House paints based on linseed oil are considered most desirable. The older white lead and zinc oxide pigments are still used but rarely alone. Such pigments are expensive and further, paint chemists have found that when used in combination with other pigments, the overall quality of the paint is greatly improved. Titanium dioxide is a good white pigment and when properly used, will form a film that is self-cleaning. Such paints, when correctly formulated, last as long as glossy types and are less likely to check or crack; they prevent excessive buildup and costly paint removal for subsequent paintings.

Interior wood surfaces are cleaned and treated much like exterior surfaces, but linseed oil paints may not be as desirable because of slow drying and a tendency to turn yellow on aging. Oleoresinous paints based on either natural or synthetic resins are usually more satisfactory.

Glossy paints or enamels based on alkyd or other oleoresinous varnishes are suitable for interior or exterior trim. Some of the new non-penetrating alkyds and latex paints are suitable for interior wooden walls. Durable and attractive finishes are obtained from varnish and other analogous materials which are applied in natural color, or over wood stains that do not obscure the grain.

Ferrous metal surfaces are painted primarily for protection against corrosion; however, decoration or appearance is often important. Proper cleaning is the initial and most important operation in painting. Any noncompatible foreign substance, even though invisible, that prevents intimate contact with the surface should be removed. The cleaning methods previously described are used. Hand cleaning and power tool cleaning are the most widely used but are the least effective; however, the surface produced is adequate for service in relatively mild environments when inhibitive primers based on raw linseed oil are used.

Paints designed to protect metal surfaces from corrosion in severe environments such as high humidity, immersion, brine, acid or alkali attack require surface cleanliness that is best obtained by careful blast cleaning or acid pickling. Tremendous improvements have been made in the life of paints for such environments by the use of synthetic resins. Unfortunately such paints are incompatible with surface contaminants such as rust, mill scale, oil and dirt.

Metal priming paints may have good rust-inhibiting properties when pigments such as red lead, zinc chromate, lead chromate, and zinc dust are used. They have limited resistance to weather and are intended to be protected by top coats designed for the purpose. Oleoresinous paints, particularly phenolics, are less permeable to moisture and oxygen than straight oil paints and are used for humid, wet, and corrosive environments. Lacquer type paints made with inert synthetic resins such as vinyls and chlorinated rubber are used when chemical attack is a factor. Thick bituminous mastics are also good for this service. Pigments such as the oxides of iron, titanium dioxide, carbon, graphite and flake aluminum are used for protective top coats; they must be chosen so that they are non-reactive with the environment or the paint vehicle. Adequate dry film thickness of paint is essential for protection. Paint should be specified on the basis of dry film thickness, not by number of coats alone.

Surface pre-treatments have been developed that are beneficial in securing good paint adhesion and preventing under-film corrosion. Hot phosphate and cold phosphate washes are used; also wash primers based upon vinyl-butyral resin. Such pre-treatments are beneficial for most paint systems on clean metal and are sometimes mandatory. Wetting oil pre-treatments are beneficial for rusty surfaces that cannot be cleaned properly.

Non-ferrous metal surfaces, such as new galvanized iron, require pre-treatment either with phosphate or phosphate-chromate solutions; or with wash-primer unless zinc dust-zinc oxide primer is used. Weathered galvanized surfaces may be painted with conventional primers.

Terne plate, if new, requires removal of oil by solvent cleaning; conventional metal primers are satisfactory, but they should be rust inhibiting. Aluminum and stainless steel require pre-treatment before painting; wash primer has given excellent results. Copper and brass do not present any particular problems other than removal or verdigris.

Concrete and masonry surfaces should be cleaned of contaminants such as oil, grease, soil and deposits of efflorescence by using wire brushes, abrasive stones or acid cleaning. Badly stained surfaces can be lightly sand blasted, or steam cleaned. Open-textured surfaces, such as cinder block, should be sealed with a cement-sand grout or a water-cement paint designed for the purpose. Close-textured surfaces which are relatively dry, such as cast concrete, asbestos-cement siding and tile, may be painted with resin emulsion paints.

Solvent type paints based on styrene-butadiene resin or chlorinated rubber are excellent paints for such purposes, particularly for exteriors. Surfaces that are aged, thoroughly dry, and that remain dry may be painted satisfactorily with oil paints.

Plaster surfaces should be clean and thoroughly dry before painting. Conventional paint systems of oil based paints are still used, but the disadvantages of long drying time, disagreeable odors, and multiple coats led to the development of water thinned (resin emulsion) paints that were generally more satisfactory. Such paints do not require special primers and satisfactory results can usually be obtained with a one-coat system. Latex paints using styrene-butadiene or acrylic resins are rapidly displacing the older paints in this field. An even newer development is the non-penetrating alkyd paints with odorless solvent; they resemble conventional paints but have many of the advantages of the latex paints.

Porous paints, such as the water emulsions of polyvinyl acetate, are useful for painting interior or exterior masonry, concrete, or plaster that is fresh, damp, or must permit the passage of water vapor in service.

Application

Quality paint supplied by the manufacturer for a specific use is usually ready for application by brush or by spray, as specified; it should be used without any unintelligent modification. Some paints are supplied at high consistencies because they would otherwise settle badly; these should be thinned as specified. Prolonged storage causes pigments to settle and skins may form on the surface. It is essential that any skin be removed and the paint remixed. It is occasionally necessary to decrease the viscosity by addition of thinners. Such adjustments should be made only as specified by the manufacturer. Thinners should be added slowly with constant stirring; addition of a large amount at once may result in flocculation of the pigments, or curdling of the vehicle, making it impossible to restore the paint to its original condition.

It is very important that most paints be applied to dry surfaces (certain emulsions and cement paints being exceptions) and that the film does not freeze or be exposed to rain or frost before drying.

If painting must continue under adverse conditions, it should be done under cover and the surrounding air heated to a satisfactory temperature. Each coat should be applied in a uniform layer free of holidays. Metal protective paints should be applied to a specified film thickness and, in multiple coat systems, it is advantageous to use contrasting colors. Should there be danger of contamination between coats, the work should be protected as much as is practical.

Adequate drying time should be allowed between coats; however, in some cases, prolonged drying may cause difficulties in applying subsequent coats.

Maintenance

The most practical way to reduce painting costs is to keep costly surface preparation a non-recurring item. This is best done through an adequate inspection and maintenance program. Any damage or faults that occur should be corrected at once. The condition of the paint system should be maintained by applying one or two overall finish coats when the old coats wear through or begin to deteriorate to the point where the primer is no longer protected.

Safety

In addition to the usual hazards associated with construction and maintenance, cleaning and painting expose workmen to dangers of fire, fumes, explosion, burns from caustics, and toxic solvents. Supervisors and foremen are generally aware of the hazards of mechanical equipment such as machinery in motion, ladders, staging, etc., but may not realize the tremendous damage that can result from the explosion of a small quantity of vaporized solvent; nor do they always appreciate the danger to health in fume and dust exposure.

Personnel engaged in hazardous cleaning and painting operations should wear protective clothing suitable for the operations involved. Force-feed respiratory equipment may sometimes be necessary.

Adequate ventilation must be supplied in close quarters to keep vapors from reaching toxic and explosive regions. Personal cleanliness should not be overlooked. Facilities should be available and workmen required to clean themselves thoroughly before eating and before leaving the job.

Discussion

J. F. Warrenfells (SAL), who sponsored this committee, presided during the discussion period.

W. H. Huffman (C&NW) wondered if the report was not too technical to be generally understood by those present, and Chairman Short replied that a report on this subject must necessarily treat the technical aspects.

In answer to a question about where a good paint for use on steel structures in brine territory could be procured, Chairman Short said that the research staff of the AREA had made many tests on various coatings and would be able to recommend a satisfactory one. R. C. Baker (C&EI) told of the work being done by the Steel Structures Painting Council.

Chairman Short concluded that he was of the opinion that much could be done to improve painting practices on the railroads, and that what is generally known as the "safety factor" in design is now being termed "ignorance factor."

Fireproofing of Timber Bridges

Report of Committee

COMMITTEE—C. E. ELLIOTT, *Chairman*, div. engr., WP, Sacramento, Cal.; H. E. RAVER, *Vice-Chairman*, engr. struct., LI, Jamaica, N. Y.; A. R. HARRIS, *Vice-Chairman* engr. br., C&NW, Chicago; G. C. BUSKIRK, repr., Pacific Coast Borax, South Minneapolis, Minn.; J. F. CANNING, pres., Southwestern Petroleum, Ft. Worth, Tex.; E. E. CASH, supv. m/w, Camas Prairie, Lewiston, Ida.; R. R. CLEGG, div. sls. mgr., American Lumber & Treating, Chicago; C. R. EHNI, lub. engr., Texas Co., Kansas City, Kan.; P. H. EVERETT, asst. supt. fire prev., IC, Chicago; J. P. GANNON, div. engr., Soo Line, Stevens Point, Wis.; C. C. GREEN, mast. carp., B&O, Wheeling, W. Va.; R. R. GUNDERSON, asst. br. engr., Sou., Washington, D. C.; G. F. PRUDE, b.&b. supv., T&NO, Houston, Tex.; C. E. HAGENMAIER, asst. supv. b.&b., SP, Los Angeles, Cal.; E. A. MANN, pres., Champion Transportation Sales, Chicago; W. F. MARTENS, gen. fore. b.&b. w.s., AT&SF, San Bernardino, Cal.; R. C. PATTON, tech. adv., Libby Zone, Charlotte, N. C.; D. A. RUHL, indus. engr., U.S. Army, Chicago; C. E. SMITH, vice-pres. (ret.), NYNH&H, New Haven, Conn.; C. H. UTLEY, vice-pres. The Zone Co., Ft. Worth, Tex.; S. G. WINTONIAK, supv. struct., PRR, Altoona, Pa.

C. E. Elliott
Chairman

The construction of timber structures to support tracks across streams, rivers, bays, marshy ground, and deep canyons was recognized as an economic and engineering necessity by the pioneer railroad builders of the past century. The subsequent development of our original railroad systems to their present vast networks of steel has not materially altered this situation, as the need for maintaining timber structures in service is still as important today as it was 100 years ago. It appears possible at this time that there will be but little change in the importance of these timber structures to many of the railroads in the next 100 years.

Those of us in the railroad industry who are directly responsible for physical maintenance of these structures, which annually require repairs varying from minor renewals to complete reconstruction of entire structures, are faced with the additional problem of maintaining these facilities as safe from fire damage as possible. To this end the maintenance departments must:

(1) Annually cut and maintain fire guards around timber structures, or spray the surrounding ground with soil sterilants.

(2) Install fire breaks at required intervals in long structures.

(3) Install and maintain water barrels and buckets and in some cases, if feasible, provide high-pressure fire lines or sprinkler systems.

(4) Carry out a planned program of converting open-deck structure to ballast decks to reduce possibility of fires starting at deck level.

(5) Install protective galvanized sheet metal, or similar, covering over tops of caps and stringers.

(6) Where possible, replace timber structures with fills or concrete and steel openings.

Not Adequate Insurance

However, the foregoing maintenance requirements, with the exception of item No. 6, are by no means adequate insurance against fires. The history of our carriers reveals that destructive fires to timber structures have annually taken a heavy toll both in the expense of reconstruction as well as in loss of revenue due to traffic interruptions. Records for the past six years show an average annual loss of $717,000 in structures alone, resulting from fires involving an average of 257 structures per year. It must be admitted that fire losses may not be severe for individual roads but the possibility of an undetected bridge fire in an isolated location very definitely represents a hazard of considerable magnitude.

In order to reduce or eliminate fire damage with resulting hazard of operation, many railroads have undertaken studies and tests to develop methods of fireproofing timber structures. The problem of fireproofing timber structures involves the seeking of a composition having sufficient insulating power to maintain timber temperatures below ignition point of both the timber itself as well as the preservative material. The protective coating should also be capable of resisting exposure to high temperatures which have a lubricating effect on the coating caused from flow of the preservative.

The extensive use of certain types of timber preservatives, while greatly increasing the life of timbers, has at the same time increased the fire hazard as materials such as creosote readily tend to support combustion, which is a very important factor in the selection of a suitable fire-retardant material.

Results of Research

A large amount of field and laboratory work has been carried out to determine the requirements of these coatings and a method is being developed for evaluating their resistance both to sudden flash fires, as typified by burning tumbleweeds, and to fires of the slower burning type. In addition, these protective coatings must be resistant to very high temperatures concentrated at one spot, such as would be found in the case of a burning fusee or hot brake shoe metal.

It is interesting to note that the temperature generated by a five-minute fusee is about 3350 deg and the temperature resulting from a flash tumbleweed or brush fire is approximately 1800 deg for a period of two to three minutes. This is a severe test for the retardant material.

Bituminous based coatings comprise the greater portion of fire retardant materials that have satisfactorily passed the tests and have been placed in practical use by many railroads. The addition of gravel screenings applied to the protective coating of deck timbers adds to the effectiveness of the retardant material and increases its life. However, the addition of such gravel coating to vertical timbers and piling is not recommended because the increased weight causes the fire-retardant coating to flow more rapidly under intense heat thus tending to expose the timber to damage. Practical tests have demonstrated that bituminous coatings require the application of a layer of glass fabric to effect proper bonding on vertical surfaces. The application of a glass fabric or mat to the undersides of caps and stringers of low structures is also recommended for adequate bonding.

Tests have shown that a structure with a deck height of 10 ft or less is vulnerable to a ground fire. Piling treated to a height of less than 7 ft above ground are likewise vulnerable. It has been developed that the application of a ¾-oz glass fabric placed on piling to a height of 10 ft above ground and sprayed with a coating of protective material 1/16 in thick was capable of withstanding ground fire temperatures of more than 1800 deg for a period of about two minutes. After the fire had died down, the protective coating was found to have dried to a brittle hardness but there was little if any damage to the glass fabric and no damage to the timber piling. In this particular test, the bottom of the deck, which was 12 ft above ground, was likewise undamaged by the fire although the timbers exuded some of the preservative material during the maximum heat of the flames but resulting in nothing more than heavy smoke.

Experiments are also being made with another type of retardant applied to vertical timbers which, when heated, gives off a flame-smothering gas. This seems to be a step in the right direction but at this time insufficient tests have been made to properly evaluate the effectiveness of the product.

At many locations and under certain physical conditions, an effective fire-retardant program should unquestionably include the piling and underside of timber decks. However, each structure under consideration for treatment should be carefully studied, as it may be possible to provide adequate protection at less expense by application of suitable sterilants to the soil under and immediately adjacent to the structure. By exclusion of all vegetation, the fire hazard is reduced and in some locations may be considered eliminated.

Weeds and Their Control

There are three types of weeds and grass: (1) Annuals; (2) biennials; and (3) perennials. Annuals have a life span of one year and are easy to destroy. Biennials have a life span of two years, and perennials live for three or more years.

There are several methods of weed control being used today. They are (1) mowing, (2) burning, (3) smothering, (4) scalping, and (5) chemicals. The first three are not generally used under pile trestles. Scalping is still being done and a good job of weed control can be obtained if the men are efficient, and the budget will stand the cost.

During the last ten years, chemicals have entered the picture and they are being used more by railroads in increasing quantities for the elimination of grass, weeds, and brush under and around bridges. There are three types of chemicals being used today: (1) Contact herbicides; (2) translocated herbicides; and (3) soil sterilants.

A contact killer is one that is capable of killing all of the top growth of the plant with which it comes into contact. There are selective and non-selective contact weed killers. The selectives may kill only certain species in a mixture of plants while the non-selectives may kill all of the plants with which they come in contact.

Translocated herbicides are applied to a plant and are carried through the stem to the roots, and the roots are destroyed or badly damaged. Translocated herbicides are usually selective and do not work on all grasses and weeds.

Soil sterilants are used to keep an area free of all vegetation for a period of time. Several of the more common chemicals used for this purpose are arsenicals, borates, boron compounds, petroleum residues, salt and sodium chlorate. Borates and boron compounds, because of their safety features, are probably the most widely employed chemicals used around and under wooden structures. The concentrated borate ore has no harmful effects on the bridge ties, piling, or hardware. It is easy to apply on areas commonly found under bridges, around piling, on slopes, and other areas where it is desirable that all vegetation be removed.

By far the greater portion of protective work undertaken so far by the various carriers involves the application of fire retardants to timber ties on steel structures and to the deck timbers of open-deck structures. In such cases, the method in common use is to apply a primer coat to all exposed surfaces. This is done with a brush or by spraying. Care should be taken to see that all cracks and crevices are filled with the material. It is also important that the wood surface to which the coating is to be applied must be free of dust and dirt, and must be dry. Experience has shown that the use of heavy-duty pumps not only gives a more complete coverage to the entire bridge deck but cuts the labor cost of applying by approximately fifty per cent.

It is recommended that a barrel of primer and a barrel of heavy-duty coating, together with pumps and a portable 60-cfm air compressor, be placed on a push car. The pump connection is fit directly to the top of the barrel; the compressor is then started and the man on the primer gun starts spraying all the ties, outer guard rail and over the ends of the caps. After he has gone about one panel, or 15 ft, the man with the heavy-duty gun starts spraying directly where the primer started and the operation is continued across the entire structure. The heavy-duty coat should be about 3/64 in thick. Immediately after the primer and heavy-duty coating have been started, other men in the crew start spreading the ¼-in or ⅜-in clean, washed gravel. The more gravel that will stick to the timber the greater the fire protection that will be afforded. Using this method and product, or equal, the deck of a single-track structure can be fireproofed at a cost of approximately $1.50 per lin ft.

In order to apply the gravel to the sides of the ties, a small chock is nailed to the top of each stringer 1½ in from each side of the tie. This chock will serve as a stop for the retaining board which is a 1-in plank the height and length of the tie. This retaining board rests across the stringers forms a V-shaped opening between the tie and the board. The aggregate is poured into this V. The retaining boards should then be temporarily nailed against the side of the tie pressing the aggregate into the coating. The boards should not be moved until the material has set and hardened. The gravel may be patted onto the ends of the ties with a gloved hand.

This treatment, however, is not completely effective on newly creosoted material unless the timber has dried out long enough to bleed out all of the surplus creosote.

An important point for bridge men to bear in mind is that most of the products in common use have volatile characteristics when first applied which have to be guarded against. After a period of from 24 to 48 hr, however, this hazard disappears.

The retardant material selected for use should have sufficient durability to be effective under all conditions of weather and service for a period of from seven to ten years. In this connection, an open-deck structure on a western railroad, which was treated with a fire-retardant and gravel coating eight years ago, was recently inspected and much of the coating was found to be in serviceable condition. It was estimated that the coating was at least 75 per cent effective. Since the time this coating was installed, however, greatly improved materials have been developed so a minimum requirement of seven years and maximum of ten years of effective serviceability does not seem at all unreasonable.

It is possible that experiments now being made to develop the application of fire-retardant material to timbers in conjunction with the preservative treatment will eventually prove successful to the extent that a considerable portion of field application of the retardant will be eliminated.

Experience with Coatings

Results of applications of fire-retardant coatings to timber deck bridges have been highly gratifying to bridge-maintenance supervisors. One large western carrier has carried out a rather extensive program in recent years involving those structures which had a previous record of fires and were considered to be particularly vulnerable. Since application of the retardant coating, fire damage has been eliminated.

An experience that another railroad had with a timber bridge is worth relating. This involved a vital 266-ft structure that had been plagued by several small fires. A serious fire which would make this bridge impassable for a time would create a difficult situation because the bridge is located in a large midwestern city and is crossed by an average of 94 trains daily. About five years ago, this bridge was treated with a fire-retardant material and since that time not a single fire has been reported on the bridge. As a result, the railroad on which the bridge was located treated a number of other key bridges in a similar manner.

It appears obvious that when tests have demonstrated the most effective types of fire-retardant material to be used, bridge-maintenance officers should thoroughly analyze their timber structure situation before proceeding with an extensive program of fireproofing. In other words, the logical development of the program should be carefully planned so as to take care of the most important and most vulnerable structures first:

(1) Structures that carry a very heavy volume of traffic where a tie-up would create an extremely difficult situation and result in heavy losses.

(2) Structures that have an unfavorable fire record.

(3) Timber structures located in isolated areas surrounded by timber and grass lands.

(4) Structures located in territory where tumbleweed collects against piling and stringers.

(5) Structures located on heavy grades where possibility of hot brake shoe metal and fusees increases the fire hazard.

(6) Fireproofing of ties on steel bridges to prevent serious damage due to warping of steel in event of fire.

(7) Structures located in areas where itinerants congregate or that are easily accessible to fishermen.

(8) Structures across waterways that are used extensively by small craft.

On the other hand, the fireproofing of structures located in important yards, terminals, or towns where adequate local fire protection is available, can usually be deferred until the latter part of the program. Likewise, timber structures which ultimately may be replaced by fills or more permanent structures should not be fireproofed pending further study of their ultimate status.

In spite of the fact that important progress has been made in recent years in the development of retardant materials and the technique of protecting bridges against fire, there has been no concerted haste on the part of railroad managements to take advantage of the numerous products available. Nevertheless, there has been some progress as a number of railroads have, in recent years, undertaken constructive programs to fireproof key structures. An increase in protective work together with continued development of improved retardants and methods can be expected in the years immediately ahead and it is the duty of bridge maintenance officers to sell their managements on the need for adequate protection and increased safety.

Discussion

R. R. Gunderson (WM), who sponsored this committee, presided during the discussion period.

E. J. Ruble (AAR) stated that there is no known fire-retardant coating which will protect the undersides of timber structures. Glass fabric will afford this protection, he said, but it is expensive.

A member questioned the economy of fireproofing timber bridges as he didn't think that the cost of replacing the few bridges that did burn out would justify the cost of fireproofing them. Mr. Ruble said that these costs will be brought down; he added, however, that a southern railroad which had 2800 ft. of trestle burn out over Lake Pontchartrain would have been very happy to have previously spent the money to make it fireproof.

T. M. Von Sprecken (Sou) said he is considering the installation of fire-warning signals for trestles at isolated points and asked for information in this regard. E. H. Haase (SP) said that several hundred bridges on his road have this protection, which consists of fusible links connected to the signal system. In the event of a fire, the fuses melt and cause the signals to display the "stop" indication.

Referring to the fire tests made on the Santa Fe on coatings applied to timber structures, a member wondered why tests were not conducted with fire-retardant treatments. Mr. Ruble said that, while fire-retardants are used for timber treatment, the tests were made with coatings to find something that would protect the many structures already in service.

C. G. Green (B&O) asked about the effectiveness of maintaining water barrels at timber structures, and H. A. Matthews (SL-SF) replied that he believed them to be useless because hunters shoot them full of holes.

Organization for Restoration of Flood Damage

Report of Committee

COMMITTEE—E. L. COLLETTE, *Chairman*, div. engr., StL&SF, Ft. Smith, Ark.; F. F. HORNIG, *Vice-Chairman*, div. engr., CMStP&P, Sioux City, Iowa; W. J. HEDLEY, *Vice-Chairman*, asst. ch. engr., Wabash, St. Louis, Mo.; A. B. CHANEY, asst. ch. engr. maint., MP, St. Louis, Mo.; C. M. COLVIN, ry. sls. engr., Armco Drainage & Metal Products, Berkeley, Cal.; G. S. CRITES, Baltimore, Md.; J. J. DAVID, asst. rdm., T&NO, Victoria, Tex.; F. T. DAY, supv. struct., PRR, New York; H. P. GREENE, supv. struct., PRR, Philadelphia, Pa.; S. N. HUTCHISON, engr., Orinoco Mining, New York; J. A. JORLETT, asst. engr. b.&b., PRR, New York; E. C. PARRISH, div. engr., IC, Vicksburg, Miss.; L. T. NUCKOLS, ch. engr., C&O, Richmond, Va., S. K. MASON, ch. engr., Texas Mexican, Laredo, Tex.; H. A. MATTHEWS, gen. fore. b.&b.-w.s., StL&SF, Amory, Miss.; H. A. SPRENGEL, asst. supv. b.&b., MP, Falls City, Neb.; F. R. SPOFFORD, asst. to ch. engr., B&M, Boston, Mass.; F. E. TARDY, asst. div. engr., SP, Tucson, Ariz.

E. L. Collette
Chairman

Restoring railroad structures damaged or destroyed by floods of major proportion calls for a compendious plan of labor, material, supplies, and equipment, with particular attention to its consist, availability and mobility. The work normally assigned to bridge and building men will be discussed, but some of the general aspects of the restoration plan wherein it affects his work will be interspersed. The report will present the plan and the attack.

Railroad managements have, generally, selected men possessed with excellent engineering wisdom for their construction and maintenance-of-way departments. As a result, pertinent records about right of way, bridges, buildings and other structures are available. In planning for the restoration of railroad structures after they have been subjected to the havoc of flood waters additional records must be acquired. These are needed to supply information about the geography, precipitation, and other meteorological characteristics of the territory.

Compilation of Records

If records of floods and their attendant damage to the railroad are not available in railroad records a search must be made for information to determine what floods might occur or have occurred and what the probable damage would be to railroad properties. First a review of the U. S. Weather Bureau Meteorologic Reports will show periods of heavy rainfall or snows. With these dates to guide, checks can be made with other railroads, highway departments, water companies, municipalities, the Corps of Engineers, Bureau of Reclamation, the surface division of the U. S. Geological Survey, and newspaper files in libraries for floodwater disturbances occurring from any sources. For this information our Canadian associates will have their own governmental sources in addition to the common sources. Keen-minded employees can be depended upon to recount events of damaged facilities and disrupted services. Flash floods having their origin from cloudbursts or failure of man-made water storage strucures are harder to track down. Washouts from them can be as damaging and costly as extensive washouts from conventional floods.

Some of the data to be recorded include dates of flood; intensity, duration, and amounts of rainfall; high-water crests; velocity of flows, quantity passing through drainage structures; character of run-offs from the watersheds traversed by the road; soil erosion; likelihood of floating debris to be cleared at structure openings or to be carried by currents. The extent of damage by specific locations and the cost of restoration can be correlated with the other data to formulate the plan of organization. In passing, it is worth noting that such information is useful in studies for elimination of floodwater damage, either by the railroad itself or in collaboration with other bodies.

With the knowledge and experience of past damage and with the data to plot the damage to be expected from future floods, the measures to combat high waters and restore the damaged railroad facilities can be formulated. Labor will generally be first in mind, probably because it will be the heaviest charge. Many sources of skilled and unskilled labor are available.

Mobilizing the Forces

Our own labor forces will get the first call. To get them mobilized quickly proper records should be kept. Divisional, regional, or system labor forces should be recorded as to name, age, craft, experience, railroad address, home address, telephone, name of immediate supervisor or gang affiliation. At the local level the supervisor or general foreman must maintain an up-to-date file of each gang under his jurisdiction. The gang foreman, generally, will have this and will supply it to his superiors. This might appear to be a duplication but its usefulness is appreciated when a foreman is called to get his gang moving immediately with their tools, equipment and such supplies as may be called for. Little time is available to round up the men. This time is better utilized in supervising the readying of tools, equipment and supplies than in calling the "hard to raise" men. The clerical force in the supervisor's or general foreman's headquarters can organize that assignment if proper records are maintained.

Regional or system offices will generally have a record of basic forces by ICC classification. At this level records of outside organizations can be maintained. These will comprise other railroads, highway or municipal construction or maintenance forces, contractors, labor procurement agencies, industrial organizations, civil defense organizations, and in some localities military organizations.

It will be economically infeasible to keep proper records of the personnel of such organizations as we keep those of our own labor. It will be sufficient to have the names of key men of the organizations with their business addresses, positions, home addresses and telephone numbers. Brief details giving the number of men in these forces, their classification, and availability for the work we are considering will be useful. It is recognized that some of the units mentioned will be fighting their own flood damage at the same time we are engaged.

The use of power tools and equipment is so extensive today among railroad bridge and building gangs that most railroads have an official who is responsible for procuring the equipment and tools, maintaining a record of the same, logging its assignments, and receiving reports of its work and condition. In the gangs the foreman must know what company-owned hand tools, power tools and equipment are assigned to him; he must also know what condition they are in.

When planning for emergencies, railroads recognize they will be forced to buy tools and equipment they might not have been able to justify for normal working operations. In planning them for this supply it must be realized that in some parts of the United States and Canada procurement of such items is utterly impossible. On the other hand adequate supply is generally available in most sections. Sources of supply and the transportation of the items should be included in the plan.

Large pieces of equipment both off and on track which are in use on nearby railroads should be included in the records. Organizations and firms having construction equipment, such as bulldozers, scrapers, cranes, shovels, pile drivers, air compressors, lighting plants, scows and small boats, and the like, should be ascertained. Key officials of these sources who are in position of authority to furnish the equipment and who can furnish intelligent information about the make, type, model, and capacity, and condition of the equipment, should be kept filed with their home and business information.

Supply houses and repair shops for the numerous kinds of equipment found on railroads and kindred organizations are to be noted. Fuels and lubricants must be supplied to the trouble zone if efficient use is to be made of equipment. The availability of airplane delivery of parts to repair out-of-order equipment during an emergency must not be overlooked. Often the parts can be delivered by plane from long distances, installed in a machine in less time than it takes to ship in a replacement machine. It is well to bring out here the usefulness of portable welding equipment and supplies during the reconstruction work. Welding is a useful tool for repairing damaged tools and equipment.

What About Materials?

Major damage from a flood results from washed-out roadbed and track-carrying structures. Materials most commonly used for track-supporting structures other than fill are piles, caps, bracing, stringers, ties and footwalks of wood or timber. Stockpiling of such materials is a common practice on railroads. This requires intelligent planning, constant watchfulness, and skillful supervision if losses are to be minimized. Railroads which use many trestle structures will find it no problem to keep emergency stocks of timber and piling. The location where it will be stored will be selected so as to be readily available, preferably out of flood zones, and accessible to the known trouble spots. Keeping the stock fresh and in suitable working condition will require rotation out of storage into schedule work. This increases its applied cost because of the extra handling, planning, and loss from being damaged or misused. Railroads which do not use much trestle material will find supplies at treating plants, at new and used timber dealers, and at some heavy construction companies. The use of heavy timber sections can be eliminated by laminating lumber using metal fasteners and various types of shear connectors. Most lumber companies carry sizes that will work adequately for making a built-up member.

Many railroads today have skillful welders in their bridge, iron, water service and shop gangs. Scattered throughout the country are small welding shops with excellent equipment and know-how. Welding is recognized as good railroad practice for the repair of steel structures. If cranes with long booms are available, pile drivers can be swung from them, and steel piles driven. Caps and stringers can be welded to them, making good structures that will act as permanent bridges. By using longer stringers the number of pile bents can be reduced. Many railroads keep fit steel in storage at strategic points.

Structures like Bailey bridges, developed in World War II, can be used to span large-sized openings left by floodwaters. These can then be crossed by equipment and men so that many work points can be organized if the damage is widespread.

When materials are stored, adequate and proper fasteners must also be stored where they will be readily available.

Some members reported that they reduced the quantity of materials in storage for emergencies by using a smaller factor of safety in designing their structures. This permitted them to get traffic moving at a slow speed. After all traffic was moving the structures were then strengthened according to good practice.

Taking Care of the Men

Feeding, housing, and welfare of labor will be included in the plan. Short-lived disruptions will require feeding arrangements at least because of the longest work days and the possible closing of the usual feeding places. For some jobs, no housing other than temporary shelters for weather protection and storage for tools and clothing are required. Railroad truck fleets, buses, or outside vehicles can transport men some distances from the site of work, either to their homes, headquarters or temporary housing facilities. The prevalence of use of the private automobile by the men may reduce the need for housing.

Where large-scale housing is needed camp cars including bunk, dining, cook, wash, tool, and storage will provide quick and serviceable facilities. There will be problems moving the wheeled equipment to the disaster area. As in the case of tools and equipment, regional or system officials will know the location of and consist of the camp trains. Similar equipment of other railroads should be kept on record.

Small housing units such as automobile trailers will usually not be found practical to care for large groups of men on short notice. Portable buildings have been used in some instances and they are found to be sufficiently useful, particularly since they can be dismantled after their service is no longer required.

When housing of large numbers of men in cars or other units is necessary, personnel familiar with the operation of a labor camp or large camp train force should be placed in charge of the unit. They should be responsible for organizing the train at the assigned yard or siding; obtaining, storing, and protecting food and other supplies. Other duties they must perform include selecting menus, providing water, light and ice, and directing proper sanitary precautions for disposal of kitchen and toilet wastes.

Charts should be posted in all camp train units listing the equipment required according to the number of men to be bedded and fed. Inventories can be taken quickly when cars are received and the missing articles replenished.

Once again, the versatility of the truck or bus makes it unnecessary to park the camp cars on top of the work at the scene of the disaster. Yards or sidings convenient to facilities can be selected. When around-the-clock work is necessary, separation of the camp site from the work site will enable the men to rest better and less disturbances to the work forces and the camp train organization will be likely.

Supervisory Personnel

It would seem redundant to say that the organization of the supervisory forces rates a high priority in any plan. If the railroad has a divisional organization, the superintendent or his representative will be responsible for the restoration when the damage is limited to one division. The magnitude of the work and the number of tricks worked in a day will dictate whether the task force will be augmented by supervision from other divisions or general offices. When the damage transcends divisional limits, then a task force should be designed which will assign proper responsibilities for the conduct of the work and avoid the chance of conflicting authority.

The personnel assigned to the task force should be reviewed frequently. Physical capabilities of men change rapidly and their compatibility for high pressure work might effect the progress of the work and the health of the man himself. Sufficient "spares" should be assigned to the task force. The success of any restoration plan will be assured if competent, vigorous, and sharp organizing maintenance and construction men thoroughly familiar with the plan are put on the team.

Thus far we have been thinking predominantly about pre-flood planning. When floods or high waters strike, all agencies competent to gather flood-water data should be sought out to get reliable information about the expected crests, the duration of the rains, and the expected subsidence of the flood waters. From railroad sources the extent of damage to railroad properties will have been reported. From the operating people information concerning the kind and amount of freight traffic delayed, the number of passenger trains affected, the ability of other railroads to make deliveries and accept shipments, and the like, will be assembled. The traffic people will learn from the shippers the effects of delays on their customers.

All this information is fed to the staff who will prepare an estimate of the situation and then a decision as to what speed is necessary to restore traffic. If speed is the essence of the restoration, the plan and information gathered about the duration of the flood should enable the task force to make an intelligent decision when the railroad will be "opened."

Getting the proper forces to the strategic places at the proper time and completion of the work as promised are the goals of all the planning. A rush to get meaningless numbers of men to the trouble zone will only compound the confusion that will naturally abound in any flooded area. Shifting of forces, equipment and material from one washout site to another without the completion of the work assigned to the contingent must be avoided. Because of the stress of the work and the vagaries of the weather it will not be possible to follow every detail set up in advance. Before any major deviations are made by any subordinates, however, the changes purportedly affecting the set plan must be reported to the authority and the work then done in agreement with his decision.

It is not the intent of this report to convey the impression that only bridge and building work required in a flooded area is the restoration of washed-out sections of the railroad. To get traffic moving is the prime consideration and this requires track on a safe roadbed and structures. Replacement or repairs to wayside structures, stations, towers, enginehouses, fuel stations, signal bridges, overhead structures, and coaling stations where they exist must be done, but this phase will generally follow after the railroad is "opened." In many instances the forces employed at particular locations will do much in the manner of cleaning up and getting their supplies and facilities in shape to work in a limited fashion.

Summing up this report, in his participation in the restoration of railroad facilities after flood damage the bridge and building man should:

(1) Have a plan for restoration of flood damage and follow it, consistent with good practice and the requirements of the restoration.

(2) Have competent and able supervision to carry out orders.

(3) Cooperate with all departments in the prosecution of the work.

(4) Use all reasonable means to keep the personnel on the job contented and interested in the progress of the work to the end that it will be done efficiently.

(5) Have a reasonable knowledge of the cost of the restoration when the work is started and keep a current record of the cost as the work is being done.

Discussion

J. A. Jorlett (PRR), who sponsored this committee, presided during the discussion period.

W. B. Warfield (PRR) remarked that, for keeping the cost of a disaster to a minimum, the number of hours that the men are worked continually should be watched closely to avoid high overtime charges. This applies also to men called from other divisions. He also pointed out that the matter of feeding the men at proper times is important in keeping them contented.

H. O. Adkins (D&RGW) stated that he depended a great deal on being able to procure the necessary work equipment from nearby local contractors on a rental basis, which cost just about the same as when using railroad equipment.

President Mayfield said that adequate rest periods for the men should be provided. Also, he said, from knowledge gained from railroad profiles, he could determine just where the water would first recede and plan his work accordingly.

Adaptation of Water Service Facilities to Dieselization

Report of Committee

COMMITTEE—R. H. BUSH, *Chairman,* wtr. serv. supv., T&NO, Ennis, Tex.; G. E. KELLY, *Vice-Chairman,* asst. supv. wtr. and fuel serv., SP, Tucson, Ariz.; R. D. HELLWEG, *Vice-Chairman,* asst. div. engr., GM&O, Bloomington, Ill.; H. O. ADKINS, gen. supv. struct., D&RGW, Denver, Colo.; A. R. BLACK, ind. engr., T&NO, Houston, Tex.; KARL CLAPPER, gen. b.&b. fore., DM&I, Duluth, Minn.; E. F. COOK, supv. w.s., MP, Little Rock, Ark.; J. E. DOBBIE, b.&b. mast., CP, Vancouver, B.C.; A. HEFTE, asst. supv. b.&b., NWP, San Rafael, Calif.; MARSHALL JARRATT, wtr. & fuel supv., SP, Tucson, Ariz.; H. J. LIESER, asst. rdm., Belt Ry., Chicago; G. E. MARTIN, supt. w.s., IC, Chicago; R. L. MYERS, supv. w.s., IC, Clarksdale, Miss.; E. R. POUND, mast. carp., B&O, Newark, Ohio; W. H. PRYOR, gen. fore. - b.&b. - w.s., StL-SF, Memphis, Tenn.; E. R. SCHLAF, asst. supt. w.s., IC, Chicago; A. W. SCHROEDER, gen. mgr., C&EI, Chicago; H. A. SELTZER, b.&b. supv., NP, Missoula, Mont.; J. M. SHORT, gen. w.s. insp., T&P, Dallas, Tex.; A. H. SIMON, engr. bldgs., CB&Q, Chicago.

R. H. Bush
Chairman

The transition from steam power to diesel power on the railroads was and is being accomplished in a comparatively short time. The diesel engine's high efficiency and low maintenance and operation costs made this change inevitable. Today some railroads are 100 per cent dieselized, while others are nearly so.

During this transition period, the railroads are faced with the task of providing diesel servicing facilities without retiring those for steam. This report will show how the railroads are meeting this problem.

Water Requirements

The steam locomotive requires large quantities of water, the treatment of which is designed to control scale, pitting, corrosion and foaming within the boiler. The diesel locomotive requires relatively small quantities of water but treatment is divided into two categories: (1) Water used for the steam generator; and (2) that used for engine-cooling water. Steam-generator water must be treated to prevent deposits of scale, and even solids usually considered soluble, from forming on the inner surfaces of the coils. Pitting and corrosion must be controlled also.

Water used for diesel engine cooling may be treated to control scale, but must be treated to prevent pitting and corrosion. Improper treatment or no treatment can result in heavy expenditures for repairs to the engine.

The quantity of water necessary to service a three-unit diesel passenger train at intermediate points is 3,600 gal maximum. If diesel units are in good condition, very little, if any, cooling water is necessary. If the train is on a close schedule, permitting only five-minute station stops, it can be seen that a delivery of approximately 250 gpm is required through each of three fill-up hoses or water cranes. How this flow may be secured will be discussed later.

Water for steam locomotives may be classified as follows:

(1) Raw water
(2) Lime-soda ash treated water
(3) Internal (soda ash-organic) treated water
(4) Zeolite-treated water

Water for diesel locomotives may be classified as follows:

(1) Raw water
(2) Lime-soda ash treated water (with or without finishing treatment)
(3) Internal (soda ash-organic or potash-organic) treated water

(4) Zeolite-treated water (with or without finishing treatment)
(5) De-ionized water with finishing treatment
(6) Corrosion-inhibiting water for cooling purposes

It is not within the scope of this report to recommend a particular treatment for various water conditions found throughout the country; however, it is becoming increasingly evident that not enough attention has been paid to this problem. We shall assume that mechanical department and operating department officers have made their wishes known as to the quality of water and the point of delivery. From this point on it is an engineering problem, but due thought should be given to the relative merits of retirement of certain facilities account of possible tax benefits.

Water Delivery

As stated above, water delivery must be given due consideration. All too often, plans are made hastily, pipe lines are reduced in size and then extended in length, restrictive valves and fittings are installed, and servicing hoses are either too small in diameter, too great in length, or of improper type. All of the above causes an increase in friction, with a consequent decrease in delivery. A booster pump is sometimes used to increase delivery but to be of benefit it should be designed to carry the full requirement for three servicing points at 250 gpm each, or 750 gpm maximum. The cost of such a pump will lead one to consider ways of reducing friction rather than offsetting the friction created by inadequate pipe and fittings.

At important passenger-train watering stations, where triple-unit diesels are serviced, a minimum of three 2½-in water-service outlets should be provided. Proper spotting of trains will actually save time as it will permit the use of shorter hose lengths. If the water supply is from a tank 40 ft high a study of friction losses at the desired rate of flow through hoses of various diameters and lengths should be made to insure that such friction losses are not in excess of the dynamic head at the inlet end of the hose. Fifty feet of 2-in hose cannot be expected to deliver 250 gpm from a full tank 40 ft above grade. Fifty feet of 2½-in smooth-bore hose will deliver this quantity of water provided there is a dynamic pressure at the inlet end of the hose in excess of 20 ft.

From the above it may be seen that 20 ft of friction loss is allowed from the 40 ft high tank to the inlet end of the hose. If each service tap is taken from a 12-in water main, the three taps delivering 750 gpm combined will produce a friction loss of less than 1 ft per 100 ft of main. It becomes obvious, therefore, that the greatest friction losses are obtained between the 12-in main and the discharge end of the hose. The service valve can be the greatest offender. Spring-loaded types are to be avoided for this reason. Valves with full straight-flow openings, such as gate valves, quarter-turn plug valves, and hydraulically operated valves with oversize waterways, are recommended. Needless to say, connecting pipes, fittings and adapters should all be kept as large as possible to avoid further friction loss.

Where conditions permit, vertical or mast-type water columns are installed. These columns, from 6 to 15 ft in height, are equipped with a ball or swivel joint with a hose of suitable diameter and length attached. The discharge-end of the hose should have a pipe thread adapter on which a diesel connection adapter may be screwed. This simplifies the purchase of hose and facilitates salvage of the diesel adapter.

Where mast or vertical columns cannot be used a long concrete or treated wood box with cover is constructed in the ground, and hose and valves are berthed in it.

In addition to the high-capacity service outlets, it is sometimes desirable to provide smaller outlets for taking on additional cooling water. The source of supply is sometimes from the steam generator supply line, in which case inhibitor treatment is added to the cooling system by hand. At important points, the inhibitor is often added proportionately to the supply. This will be discussed later. A flow rate of approximately 10 gpm is all that is required.

Water Treatment

As stated above two types of water are required for diesel engines. Steam generator water will be discussed first.

Deionized water with finishing treatment is considered the ideal steam generator water. However, because of economic considerations it is not always the most practical treatment. The dissolved solids content of the water must be considered as the generator coils actually become coated with normally soluble salts because of very high boiler-water concentrations. Efforts are being made to partially overcome this difficulty by the use of potassium salts rather than the conventional sodium salts. This aids materially due to much greater solubility of the former as compared to the latter at elevated temperatures. Certain types of very hard water can be softened economically and to a very low solid content value by means of lime-soda ash treatment; others cannot. The chemical engineer must make a study of each supply to determine whether a given water can be treated in a given manner to render its quality acceptable to the mechanical department.

Likewise, zeolite treatment will not consistently produce a trouble-free water in all instances. Some railroads provide treatment on the locomotive; the treatment is added automatically as water is taken or as water is fed to the boiler. A large percentage of water-treating plants for treating steam locomotive water consisted of soda-ash plants. However, quite a few railroads use zeolite treatment for their diesel water supply. It has been found that zeolite treatment is superior to soda-ash treatment for diesel service and some roads having soda-ash plants are replacing them with zeolite plants.

Zeolite softeners, completely automatic in operation, are available. These plants with the aid of water meters with transmitter heads, and various relays and electrically actuated valves will deliver soft water with no attention other than keeping the brine tank full. They may be installed in present water treating facilities and hooked up to existing water mains where practical. Deionizing systems may be installed in existing facilities also. To determine the desired capacity of such a system or a zeolite system it is recommended that it be submitted for competitive bidding to at least three engineering firms. The water analysis, coupled with the desired flow rates and regenerant capacity, must be considered.

The finishing treatment recommended for zeolite and deionizing plants, usually a potassium-organic-sulfite mixture, may be added to the plant effluent by means of a chemical vat, agitator and pump, automatically operated. The potassium salt scavenges residual hardness, the organic material acts as a sludge conditioner, and the sulfite compound prevents corrosion.

Cooling water treatment may be classified as follows: (1) Chromate, (2) non-chromate, and (3) organic.

Chromate treatment is easily soluble and can be made up into a highly concentrated vat solution. It lends itself nicely to proportionate feed. It can be added to the cooling water as the diesel is being serviced, or it can be proportionately fed to the cooling water as it fills a storage tank. Its one disadvantage is toxicity. Utmost care must be used to prevent any possibility of a cross-connection between chromate-treated water and any potable supply.

Borate treatment, often referred to as "non-chromate" treatment, is difficult to dissolve unless temperatures are raised. A highly concentrated solution is not feasible because of this characteristic. Therefore, this type of treatment usually is slug-fed to the engine and no facilities need be provided by the engineering department.

There is on the market a new organic type inhibitor that is in liquid form, therefore soluble in any concentration lending itself nicely to proportionate automatic feed. It is non-toxic and no more costly than chromates. This shows promise of giving good corrosion inhibition, and may solve some of the problems of chromate toxicity and non-chromate inhibitor solubility.

Conclusion

Until steam locomotive water softeners have disappeared from service, it will be the responsibility of supervisors to make the best possible use of materials and equipment available in adapting them to diesel service. Water treatment for diesel service is under continuous study and results of these studies are made available from time to time. Supervisors should always be open minded and receptive to any improvements that may be suggested.

Since it is necessary to provide water facilities for both diesel and steam locomotives until the latter have been retired from service, some installations for serving diesels will be more or less on a temporary basis, and, too, it is not definitely known, in some instances, where diesel facilities will finally be located. So, for these reasons, water service facilities for diesels may have to be installed at the most convenient locations for the time being.

Discussion

E. R. Schlaf (IC), who sponsored this committee and presided during the discussion period, stated he believed that one of the most difficult problems for the water service men was that of reducing the friction loss in water-delivery lines to diesel power units. Friction can be substantially reduced at many locations, he added, by taking advantage of the larger water mains that were previously installed for steam service. In some instances, these old installations may be overlooked.

Trends in Modernization of Freight Stations

Report of Committee

COMMITTEE—R. C. Baker, *Chairman,* engr. struct., C&EI, Danville, Ill.: W. C. Oest, *Vice-Chairman,* prin. asst. engr., FtW&D, Fort Worth, Tex.; B. L. Bright, *Vice-Chairman,* asst. to engr. bldgs., ACL, Wilmington, N.C.; W. R. Arniel, asst. supv. struct., PRR, Pittsburgh, Pa.; R. F. Beck, asst. engr., EJ&E, Joliet, Ill.; W. F. Bowden, Jr., asst. arch., Sou., Knoxville, Tenn.; J. A. Campbell, supv. struct., PRR, Camden, N. J.; Arthur Eble, asst. supv. b. & b., StLSW, Tyler, Tex.; C. Johnston, div. engr., L&N, Birmingham, Ala.; C. A. McLeod, b.&b. supv., AT&N, York, Ala.; W. R. Meeks, supv. b.&b., MP, Falls City, Neb.; A. P. Milne, supv. b.&b., NYC&StL, Frankfort, Ind.; D. E. Perrine, asst. ch. engr., C&WI, Chicago; E. F. Snyder, asst. to ch. engr., IC, Chicago; B. M. Stephens, asst. ch. engr., T&NO, Houston, Tex.; F. J. Stewart (ret.), civil engr., Hollywood, Fla.; S. C. Walker, supv. struct., PRR, Chicago; L. C. Winkelhaus, asst. arch. engr., C&NW, Chicago.

R. C. Baker
Chairman

Several railroads have started a long-range freighthouse modernization plan. This is a large undertaking requiring large expenditures and must be spread over a long period of time. Most of the railroads are concentrating on the modernization of the larger stations and this report will deal only with these larger structures.

Due to variations in climate, geographical location, availability of various building materials and local requirements and regulations, it is rather difficult to outline general trends in modernization of freight stations. However, some of these trends are constant throughout the country and these will be mentioned in this report.

Present Freight Stations

Modernization of a present freight station might well include changes in the exterior to reduce roof and wall areas and to improve the general appearance. This may be done by tuck-pointing the brick-work; application of stucco on exterior of old brick walls; the replacement of wood sash with steel sash; and the application of a fire-resistant roof.

Door openings may be changed to accommodate present-day trucks and trailers and provide more space for the unloading of trailers and trucks. Doors may be changed from the old-style sliding or hinged type to modern overhead doors, and these may be manually or power operated.

In planning interior changes or improvements in a freight station, consideration should be given to the fact that the wheel loads of various types of mechanical equipment now used for handling shipments impose severe conditions of loading and wear on a floor. To withstand these conditions wood-plank floors may have to be reinforced and the wearing surface improved, or the entire floor replaced with concrete or asphalt.

Where space is restricted and the volume of business is such that large numbers of mechanical tow units would lead to congestion of traffic the installation of a continuous overhead or underfloor towing system for platform trucks may be installed. Both systems have been installed in late years. One of the governing factors between the overhead or underfloor type may well be the type of framing that was used in the original freight station, that is, whether the present overhead trusses or steel work will support a modern overhead tow system. In case it will not, it will probably be more economical to place the towing chain under the floor.

A service shop with adequate facilities for maintenance, fueling, lubrication and repairing of lift trucks, tractors and trailers should be provided in or near the freight station. It should be heated, have facilities for charging batteries and be separated from the remainder of the freight station by a suitable firewall.

Toilets should be provided at suitable locations so that employees will not waste time traveling to and from them. Proper locker and lunchrooms for employees are desirable and in some states the industrial and wash-house laws will govern. In constructing toilet, wash and locker rooms, fireproof materials should be used as far as practicable and walls of impervious material, such as tile, are preferred, as they are easy to clean and have a low maintenance cost.

In most cases the lighting system will require replacement to provide sufficient illumination for efficient operation of the station on overcast days or at night. Outlets should be provided at suitable locations for use of drop cords to facilitate the lighting of a box car or truck during loading or unloading operation. The lighting can be improved materially by painting the ceiling and upper half of the walls with light-colored paint, or the installation of translucent panels in the roof or side walls.

Adequate communication facilities are a necessity. Talk-back systems between checkers and the office, gangs and box cars or trucks have proved effective. Loudspeaker systems have been used effectively to direct and coordinate the operation of lcl freight terminals. A pneumatic-tube system between the general freight office and the warehouse foreman's office can speed the transfer of waybills and messages.

The office portion of a large freight station is an important part of the structure. Consideration should be given to air conditioning, heating, suitable color combinations, proper lighting, acoustical treatment and floor covering.

An example of the modernization of a freight station is the Erie freighthouse in Chicago. The freighthouse proper is a two-story brick structure with wood and steel framing, timber floor joists and wood flooring. There is also a basement under this freight station. Spanning the main freighthouse floor, and supporting the second floor, are steel girders on which was mounted the supports for an overhead towing system.

The entire basement was cleaned, painted, new lighting fixtures installed and placed in first-class condition for storage of materials and freight. A new elevator serving the basement and first and second floors was installed. An inclined conveyor leading from the first floor to the second floor and connected to a rotary type sorting table on the second floor for the transfer and sorting of small packages was installed. An intercommunication system was installed between the offices and strategic locations in the house. A complete new lighting system was also installed throughout the house.

All tracks were stubbed at south end, and at the south end or rear of the freighthouse a brick-and-steel addition was constructed to provide for a repair shop, freighthouse truck storage and a platform connection between freighthouse proper, an island platform and an outbound platform. No changes were made in the exterior to reduce wall and roof areas.

New Freight Stations

In the construction of new freight stations different types of construction may be used depending upon the availability of various building materials, their cost and service life.

In general the foundations will be of concrete, the superstructure of steel with masonry curtain walls, corrugated asbestos siding or steel wall panels, or masonry bearing walls or tilt-up concrete slab construction; the roof framing and roof will be of fire-resistant materials and consisting of either poured-in-place or precast slabs, corrugated asbestos roofing or the different types of steel roof decking; and the floors should be concrete slab or, if some type of wearing surface is desired over the concrete slab, it can be installed of the most desirable and recommended material and placed in the manner recommended by the manufacturer.

Doors should be of the overhead type, and may be either wood or metal and may be either manual or power operated. Windows may be either wood or metal, depending on location and their use and the comparative costs.

The only type of new construction that has been brought to our attention for this report is the use of tilt-up concrete slabs. These have been used in the past in the southwest for freighthouse construction, the Fort Worth & Denver having just recently completed a new freight station in West Texas of which the warehouse is 50 ft wide and 250 ft long with walls 13 ft 9½ in high. The warehouse floor is 4 ft above top of rail and consists of concrete laid on a compacted fill. The tilt-up walls are 6 in thick and the pilasters were poured in place on 16-ft centers, the walls were spray painted on both sides and the roof deck is of gypsum slabs supported by long-span steel bar joists, 4 ft center to center.

Another example of this type of construction is a new 40-ft by 408-ft reinforced concrete warehouse built at Dallas, Tex., by the St. Louis Southwestern, using the tilt-up wall slab construction. The cost of this type of construction is such as to make it competitive with steel frame and curtain-wall construction using either corrugated asbestos or metal wall panels.

As mentioned under the modernization of present freight stations it is necessary to provide good lighting in the warehouse and in the office. The office space will also require proper heating and ventilation and the heating system may be either of hot water or steam radiation or forced hot air, using either oil or gas for fuel depending on their availability. An air-conditioning system is often desirable, for office space in a modern freight house. The office should also be provided with the proper kind of acoustical ceiling and a resilient floor covering, and should be decorated by using a suitable color scheme.

An example of recent construction of a large freight terminal is the new Santa Fe freighthouse at Chicago, having a total width over platform and tracks of 203 ft 8 in and a total length of 1,352 ft 7 in. Six spur tracks serve these platforms. The inbound platform on the east and the outbound platform on the west are each 45 ft in width. The island or center platform is 30 ft in width. All platforms are served by an underfloor type towing system. This freight station is so constructed that the cars placed for freight house loading or unloading are under roof.

The type of construction consists of concrete foundation and platforms, with steel framework using four spans of roof trusses for carrying the roof structure over tracks and platforms. Steel purlins support the metal roof deck. Originally no doors were installed in this freighthouse but they are now being placed. Across the front of this freight platform is a brick and reinforced concrete freight office approximately 22 ft by 248 ft in plan.

Another example is the new Missouri Pacific freight station at St. Louis, which is 312 ft wide and 753 ft long. Here, as in the Santa Fe station, the roof covers the tracks as well as the platform. There are eight stub tracks inside the building and four tracks open at each end. Here crossover bridges are used for trucking over the tracks between the platforms; they are not using any kind of conveyor system for handling freight at this time but are using tractors and trailers. The general construction consists of concrete foundations and platforms; steel framework construction of rigid-frame design; steel roof purlins; and corrugated asbestos roofing. Across the front of the freighthouse platform is the modern two-story office building completely air-conditioned; also a room housing a cooperage shop and a room for making repairs to tractors and trailers.

Still another example is the Burlington freight station located at 20th and Morgan in Chicago. The main section of this freighthouse is 50 ft wide, one island platform is 45 ft in width, and two island platforms are 50 ft in width. The main section and each island platform are separated by three tracks with lift bridges spanning the tracks for trucking between the various platforms. The main section is of reinforced concrete construction with brick walls for a second-story office over the length of the platform.

The total dock length is approximately 1050 ft. The island platforms consist of concrete floors, steel framework with metal siding or asbestos above the doors, steel roof purlins, precast featherweight concrete roof tile and built-up roof over the tiles. All platforms are served by an overhead towing system.

From the above it is evident that each freight station presents its own problems, and it is obvious that no two freight stations could be modernized or constructed in the same manner. A complete study of the requirements, of the total space to be provided, of the manner in which the freight will be handled is necessary by the operating and engineering departments. After this data has been compiled, it is then necessary to plan and design a structure that will meet these requirements in the most economical manner, taking into consideration the life that will be required for the structure and the annual maintenance for the different types of construction in order that the most economical construction may be used.

Discussion

Chairman Baker presided during the discussion period.

W. B. Warfield (PRR) commented on the use of steel trusses for freight stations and recalled an instance where the lading within the house got on fire and overheated the steel trusses which collapsed, bringing down the walls with them and creating a worse condition for extinguishing the fire. Chairman Baker was of the opinion that, when the fire was that intense, the walls and trusses of timber construction would create a similar condition.

T. E. Jackson (SP) said that when old stations are being modernized, he has replaced the wood platforms with precast concrete slabs. supported by rails spanning concrete pedestals.

J. S. Hancock (DT&I) said that an overhead door, 22 ft wide, sounded like a fine thing but, when opened during winter for taking in lading, the cold air rushed in and rapidly cooled the interior. He thought that sliding doors were preferable. Chairman Baker stated that his road does not heat freighthouse interiors and the doors are opened in the morning and stay open until the house is closed at night. Also, he said, sliding doors must have a housing of some kind to prevent lading from jamming them.

When W. H. Bunge (MP) inquired about the economy of using tilt-up wall construction, W. C. Oest (FW&D) said that it effected a saving of about 12 per cent over conventional construction.

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Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck J. L. White A. Shane A. S. Markley W. M. Noon J. M. Staten	W. O. Eggleston W. M. Noon J. M. Staten G. J. Bishop C. P. Austin M. Riney	G. J. Bishop C. P. Austin M. Riney Wm. S. Danes J. H. Markley W. O. Eggleston	Wm. S. Danes J. H. Markley W. O. Eggleston R. L. Heflin F. W. Tanner A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. F. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain R. L. Heflin F. W. Tanner A. Zimmerman H. D. Cleaveland A. Montzheimer	T. M. Strain H. D. Cleaveland F. W. Tanner A. Montzheimer W. E. Smith A. W. Merrick	A. Montzheimer W. E. Smith A. W. Merrick C. P. Austin C. A. Lichty W. O. Eggleston	W. E. Smith A. W. Merrick C. P. Austin C. A. Lichty W. O. Eggleston J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	H. H. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullem	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnston	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Jonhston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934-1935	1935-1936	1936-1937	1937-1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCoy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938-1939	1939-1940	1940-1941	1941-1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary	....	....	F. O. Whiteman	A. G. Shaver
Treasurer	....	....	F. E. Weise	F. E. Weise
Directors	L. G. Byrd W. R. Ganser F. H. Soothill B. R. Meyers W. Walkden A. S. Krefting	B. R. Meyers W. Walkden A. S. Krefting A. M. Knowles L. G. Byrd K. L. Miner	N. D. Howard L. G. Byrd K. L. Miner R. E. Caudle I. A. Moore W. A. Sweet	R. E. Caudle I. A. Moore W. A. Sweet J. L. Varker L. E. Peyser Martin Meyer

	1942-1943	1943-1944	1944-1945	1945-1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer L. E. Peyser K. L. Miner F. G. Campbell J. S. Hancock L. C. Winkelhaus	W. F. Martens A. L. McCloy L. C. Winkelhaus E. H. Barnhart A. B. Chapman L. E. Peyser	W. F. Martens A. L. McCloy L. C. Winkelhaus E. H. Barnhart A. B. Chapman L. E. Peyser	A. B. Chapman W. A. Huckstep F. R. Spofford Guy E. Martin B. R. Meyers L. E. Peyser

†To November 1, 1942
‡To February 1, 1943

	1946-1947	1947-1948	1948-1949	1949-1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
Directors	Guy E. Martin B. R. Meyers L. E. Peyser H. M. Harlow H. B. Christianson F. R. Spofford	H. M. Harlow H. B. Christianson F. R. Spofford Lee Mayfield Franz M. Misch W. D. Gibson	Lee Mayfield F. M. Misch W. D. Gibson H. M. Harlow V. E. Engman G. W. Benson	H. M. Harlow V. E. Engman G. W. Benson F. M. Misch L. R. Morgan J. A. Jorlett

	1950-1951	1951-1952	1952-1953	1953-1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	J. A. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	J. A. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	F. M. Misch L. R. Morgan J. A. Jorlett M. H. Dick R. R. Gunderson J. F. Warrenfells	M. H. Dick R. R. Gunderson J. F. Warrenfells W. H. Huffman L. R. Morgan B. M. Stephens	W. H. Huffman L. R. Morgan B. M. Stephens M. H. Dick J. F. Warrenfells G. Switzer	M. H. Dick J. F. Warrenfells G. Switzer B. M. Stephens W. H. Bunge E. R. Schlaf

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1.** The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings, water service facilities, and other structures, by investigation, reports and discussions.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1. The membership of this association shall be divided into five classes, viz: Members, life members, associate, honorary and junior members.*

Section 2.** A member shall be a person in a position above rank of gang foreman in connection with railway bridge, building and water service work. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3.** To be eligible for a life membership a member must have belonged to the association for at least twenty years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of active membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2, of this Article.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members present at a regular meeting. They shall have all the rights of active members except that of holding office and shall be exempt from the payment of dues.

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*Amended October 16, 1941.

**Amended September 20, 1948.

Section 6. A junior member shall be a person who is a graduate of a recognized engineering school, or who has been employed for at least two years in the design, maintenance or construction of railway bridges, buildings or structures. Applicants shall be at least 21 years of age and they shall be elected in the manner prescribed for members, in Section 2 of this article. Juniors shall have all the rights of members except that of holding office. When the attainments of a Junior are such as to qualify him as a member, he may apply for promotion and the Executive Committee shall authorize such promotion when qualifications warrant the action. Unless a Junior is promoted, his membership shall cease automatically when he becomes 28 years of age.*

Section 7. Any member guilty of conduct unbecoming to a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 8. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 9.** Only active members shall hold office in this association, and only active and life members shall be entitled to vote in the election of officers.

ARTICLE IV.

OFFICERS

Section 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer and six directors who with the most recent past president shall constitute the executive committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members, shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1.** The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE

Section 1. Except as otherwise provided, the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

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*Amended October 16, 1941.

**Amended September 20, 1948.

Section 2.† The president, four vice-presidents, secretary and treasurer shall hold office for one year and the directors for two years, three directors being elected each year. All officers retain their offices until their successors are elected and installed.

Section 3.† The term of office of the secretary and the treasurer may be terminated at any time by a two-thirds vote of the executive committee. Their compensation shall be fixed by a majority vote of the executive committee.

The secretary shall also serve as secretary of the executive committee.

Section 4. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the executive committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1.† Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.*

LOCAL SECTIONS

Section 1.** Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee of the association approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

BY-LAWS

TIME OF MEETING

1.** The regular meeting of this association shall convene annually during the month of September, the exact date to be fixed by the Executive Committee.

PLACE OF MEETING

2.** The place of holding the annual convention shall be Chicago, Ill.

3. It shall lie within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

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†Amended October 17, 1940.

*Article adopted 1922.

**Amended September 20, 1948.

**DUES

5. The annual dues, for the fiscal year ending August 31, and payable in advance, shall be as follows:*

Members, $5.00; Associate Members, $4.00; Junior Members, $2.50.

DUTIES OF OFFICERS

6.† The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8.† It shall be the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts, between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.‡ The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10.♯ After each annual meeting the president shall appoint a committee consisting of five members. Two Past Presidents shall be members of this committee, one of whom shall act as Chairman. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual convention in accordance with ARTICLE VI of the Constitution, said list to be read at the business session of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

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†Amended October 17, 1940.
‡Adopted October 17, 1940.
*Amended October 16, 1941.
**Amended September 20, 1948.
♯Amended December 4, 1950.

PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS

15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's rules of order.

AMENDMENTS

17.† The By-Laws can be amended by a two-thirds vote of those present at any regularly called Executive Committee Meeting.

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†Amended September 20, 1948.

DIRECTORY OF MEMBERS

as of April 1, 1955

(Figure after each name indicates year when member joined the association)

HONORARY MEMBERS

Barnhart, E. H. (Retired) Div. Engr., B. & O., St. Petersburg, Fla. (1941)
Bechtelheimer, A. E., (Retired) Br. Engr., C. & N. W., Chicago, Ill. (1920)
Budd, Ralph, (Retired) President, C. B. & Q., Santa Barbara, Calif. (1927)
Buford, C. H., (Retired) President, C. M. St. P. & P., Washington, D. C. (1946)
Chinn, Armstrong, President, T. R. R. A. of St. L., St. Louis, Mo. (1930)
Crites, G. S., (Retired) Div. Engr., B. & O., Baltimore, Md. (1912)
Strate, T. H., (Retired) Div. Engr., C. M. St. P. & P., Lanikai, Oahu, T.H. (1918)
Vandenburgh, E. C., (Retired) Ch. Engr., C. & N. W., Chicago, Ill. (1925)

ACTIVE MEMBERS

A

Aaron, J. L., B. & B. Insp., W. M., Cumberland, Md. (1954)
Adkins, H. O., Gen. Supv. B. & B., D. & R. G. W., Denver, Colo. (1953)
Ainslie, A. F., Supv. B. & B., N. P., Spokane, Wash. (1948)
Allen, G. A., Supv. B. & B., C. & O., Columbus, Ohio (1952)
Anderson, A., Spec. Asst. Engr., N. Y. C., Chicago, Ill. (1947)
Anderson, A. C., Gen. B. & B. For., D. M. & I. R., Two Harbors, Minn. (1952)
Anderson, J. L., Supv. B. & B., M. P., Osawatomie, Kan. (1931)
Andrews, J. T., Spl. Engr., B. & O., Baltimore, Md. (1947)
Armstrong, W. F., Arch'l. Engr., C. & N. W., Chicago, Ill. (1947)
Arniel, W. R., Asst. Supv. Struc., Penna., Pittsburgh, Pa. (1953)
Atkinson, T. J., Supv. of Struc., Penna., Pittsburgh, Pa. (1947)

B

Babbitt, J. H., Div. Engr., B. & O., Indianapolis, Ind. (1946)
Babcock, D. L., Supv. B. & B., C. & N. W., Fond du Lac, Wis. (1953)
Baker, B., Asst. Supv. B. & B., C. & O., Saginaw, Mich. (1950)
Baker, R. C., Engr. of Struc., C. & E. I., Danville, Ill. (1940)
Barr, H. L., Div. Engr., C. & N. W., Boone, Ia. (1938)
Barranco, S. J., Asst. Supv. Struc., Penna., Cincinnati, Ohio (1951)
Beam, Y. C., Asst. Mast. Carp., S. A. L., Americus, Ga. (1945)
Beaver, J. F., Ch. Engr., M. of W. & Struc., Sou., Charlotte, N. C. (1950)
Beck, R F., Asst. Engr., E. J. & E., Joliet, Ill. (1952)
Benson, G. W., Supt. Br., C. of Ga., Macon, Ga. (1940)
Benson, O. C., Asst. to Engr. M. of W., B. & M., Boston, Mass. (1952)
Bergeron, J. A., Asst. B. & B. Mast., C. N., Cochrane, Ont., Can. (1949)
Beringer, M. A., Br. Inspr., I. C., Chicago, Ill. (1929)
Beynon, H. G., B. & B. Mast., C. P., Brandon, Man., Can. (1951)
Bills, R. W., Asst. Engr., M. P., Harlingen, Tex. (1953)
Bisbee, R. D., Div. Engr., P. & S. F., Slaton, Texas (1947)
Bishop, I. A., Asst. Mast. Carp., S. A. L., Jamestown, S. C. (1955)
Black, A. R., Indstrl. Engr., T. & N. O., Houston, Tex. (1953)
Blake, J. E., Jr., Asst. Supv. Struc., Penna., Harrisburg, Pa. (1953)
Block, M., Engr. of Br., I. C., Chicago, Ill. (1948)
Bober, H., B. & B. Engr., G. M. & O., Mobile, Ala. (1947)
Bodie, B. V., Ch, Engr., G. M. & O., Mobile, Ala. (1951)
Boehling, H. A., Jr., Asst. Supv. B. & B., C. & O., Richmond, Va. (1948)
Boling, E. C., Supv. B. & B., N. S., Cary, N. C. (1950)
Borchert, W. C., Div. Engr., K. C. S., Shreveport, La. (1942)
Bowden, W. F., Jr., Asst. Arch., Sou., Knoxville, Tenn. (1953)

Bowman, H. A., Mast. Carp., Ft. W. & D. C., Wichita Falls, Tex. (1953)
Bowman, R. M., Gen. Fore., Penna., Johnstown, Pa. (1954)
Brandimarte, J. J., Jr., Supv. Struc., Penna., Cleveland, Ohio (1947)
Brice, W. T., B. & B. Mast., C. N., Regina, Sask., Can. (1946)
Bridjette, E. C., B. & B. Supv., S. P., Los Angeles, Calif. (1950)
Bright, B. L., Asst. to Engr. Bldgs, A. C. L., Wilmington, N. C. (1953)
Broome, W. S., Asst. Ch. Engr., C. & S., Ft. W. & D., Denver, Colo. (1954)
Brouse, R. G., Mast. Carp., C. B. & Q., Chicago, Ill. (1951)
Brown, G. A., Gen. Fore., B. & B., A. T. & S. F., Wellington, Kan. (1953)
Brown, I. D., Insp. W. S., C. & O., Huntington, W. Va. (1952)
Brown, L. W., B. & B. Supv., C. & O., Peru, Ind. (1951)
Bruns, M. W., Bd. Engr., T. R. R. A. of St. L., St. Louis, Mo. (1954)
Buckmaster, W. A., Asst. Div. Engr., B. & O. C. T., Chicago, Ill. (1951)
Budzenski, F. N., Gen. Fore., C. & N. W., Antigo, Wis. (1938)
Bunch, A. H., Br. Inspr., St. L.-S. F., Springfield, Mo. (1951)
Bunge, W. H., Asst. Engr., M. P., Houston, Tex. (1941)
Burch, E. E., Br. Engr., C. M. St. P. & P., Chicago, Ill. (1945)
Burford, A. E., Gen. For. B. & B., I. C., Memphis, Tenn. (1947)
Burkel, J. N., Draftsman, M. P., St. Louis, Mo. (1951)
Burner, P. D., Asst. Gen. Supv. Struc. & Wk. Eqpt., W. P., Oakland, Calif. (1953)
Burrows, C. D., Mast. Carp., B. & O., Wilmington, Del. (1946)
Bush, R. H., W. S. Supv., T. & N. O., Ennis, Tex. (1952)

C

Caines, W. W., Supv. B. & B., C. & O., Huntington, W. Va. (1938)
Caldwell, F. O., Mast. Carp., S. A. L., Raleigh, N. C. (1951)
Camelle, E. J., Asst. B. & B. Supv., T. & N. O., Houston, Tex. (1954)
Campbell, J. A., Supvr. Str., PRR, New York, N. Y. (1951)
Campbell, J. E., Gen. Supv. M. of W. S. Weld., W. P., Lafayette, Calif. (1954)
Carothers, M. D., Asst. Ch. Engr., G. M. & O., Bloomington, Ill. (1938)
Carter, J. W., B. & B. Supv., Virginian, Roanoke, Va. (1947)
Carter, T. S., Ch. Engr., M. K. T., St. Louis, Mo. (1954)
Cary, J. R. III, Asst. Supv. B. & B., C. & O., Hinton, W. Va. (1954)
Cary, N. M., Asst. Div. Engr., Sou., Greenville, S. C. (1953)
Cash, E. E., Supv. M. W., Camas Prairie, Lewiston, Idaho (1953)
Chaffin, E. S., Supv. B. & B., N. & W., Crewe, Va. (1954)
Chamberlain, P. C., Asst. to Engr. of Struc., Erie, Cleveland, Ohio (1941)
Chaney, A. B., Asst. Ch. Engr. Sys. Mtce., M. P., St. Louis, Mo. (1947)
Cheney, R. R., Ch. Carp., C. M. St. P. & P., Marion, Iowa (1953)
Christianson, H. B., Asst. Ch. Engr. Sys., C. M. St. P. & P., Chicago, Ill. (1928)
Clapper, K., Gen. Fore. B. & B., D. M. & I. R., Proctor, Minn. (1953)
Clark, K. L., Prin. Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1939)
Clise, W. E., Supv. B. & B., W. M., Frostburg, Md. (1953)
Clouette, H. F., Asst. B. & B. Supv., N. W. P., San Rafael, Calif. (1953)
Cole, G., B. & B. Gen. For., A. T. & S. F., Burlingame, Kan. (1949)
Collette, E. L. Sr., Div. Engr., St. L.-S. F., Ft. Smith, Ark. (1949)
Collier, P. B., Supt. of Scales, M. P., St. Louis, Mo. (1938)
Collings, J. E., Ch. Carp., C. M. St. P. & P., Savanna, Ill. (1953)
Collum, R. L., Mast. Carp., S. A. L., Jacksonville, Fla. (1941)
Colvin, A. A. (Ret.), Div. Engr., C. & N. W., Norfolk, Nebr. (1937)
Colvin, C. S., Asst. Engr. of Str., I. G. N., Houston, Tex. (1951)
Combs, G. L., Gen. Fore. B. & B., A. T. & S. F., Fresno, Calif. (1951)
Converse, D. W., Br. Engr. A. C. & Y., Akron, Ohio (1940)
Cook, E. F., W. S. For., M. P., Little Rock, Ark. (1947)
Cook, R. F., B. & B. Supv., I. C., Vicksburg, Miss. (1954)
Cooledge, V. R., Asst. Engr. Br., S. P., San Francisco, Calif. (1953)
Corporon, F. J., Supt. W. & Struc., C. S. S. & S. B., Michigan City, Ind. (1950)
Cox, R. C., B. & B. Supv., W. P., Sacramento, Calif. (1950)
Cox, W. R., Div. Engr., S. A. L., Americus, Ga. (1954)
Creed, T. F., Jr., Res. Engr. Bridge Dept., Sou., Washington, D. C. (1954)
Crews, C. H., Supv. B. & B., I. C., Jackson, Tenn. (1947)
Croft, P. H., Asst. Engr. M. of W., I. C., Memphis, Tenn. (1947)
Crouch, H. M., W. Serv. Supv., T. & P., Bunkie, La. (1954)
Crounse, W. E., B. & B. Supv., D. & H., Carbondale, Pa., (1945)
Cruikshank, A. W., Gen. Plumb. For., D. & H., Green Island, N. Y. (1950)
Cummings, E. M., Div. Engr., B. & O., Garrett, Ind. (1954)
Cummings, J. W., Supv. Wk. Equip., D. & H., Albany, N. Y. (1947)

Cummins, C. P., Asst. Engr., M. K. T., St. Louis, Mo. (1948)
Cunningham, J. F., Ch. Br. Insptr., B. & M., Boston, Mass. (1951)
Curie, H. D., Mast. Carp., B. & O., Garrett, Ind. (1942)

D

David, J. J., Asst. Rdm., T. & N. O., Victoria, Tex. (1953)
Davis, G. B., B. & B. Supv., N. Y. C., Columbus, Ohio (1942)
Davis, H. E., Supvr. B. & B., N. Y. C. Sys., Mattoon, Ill. (1940)
Davis, L. H., Gen. For. B. & B., A. T. & S. F., Amarillo, Tex. (1948)
Davis, R. E., Supv. of Str., D. & R. G. W., Salt Lake City, Utah (1954)
Day, F. D., Supv. Struc., Penna., New York, N. Y. (1949)
Demmon, H. R., Asst. Gen. B. & B. Insptr., S. P., Albany, Calif. (1948)
Deno, L. J., Div. Engr., C. & N. W., Sioux City, Iowa (1947)
DeWitt, E. C., Asst. B. & B. Supvr., S. P., El Paso, Tex. (1955)
Dick, H. M., Supv. of Struc., Penna., Harrisburg, Pa. (1942)
Dick, M. H., Ed., Ry. Trk. & Struc., Chicago, Ill. (1937)
Dickison, C. S., Asst. Supv. B. & B., C. & O., Covington, Ky. (1953)
Dilworth, R. W., Drafts., N. Y. C., Detroit, Mich. (1953)
Dixon, N., B. & B. Mast., C. N., Montreal, Que., Can. (1949)
Dobbie, J. E., B. & B. Mast., C. P., Vancouver, B. C., Can. (1953)
Dodson, F., Asst. Supv. B. & B., C. & O., Covington, Ky. (1948)
Doerr, R. W., Asst. Supv. B. & B., C. & O., Peru, Ind. (1953)
Dove, R. E., Assoc. Ed., Ry. Trk. & Struc., Chicago, Ill. (1934)
DuBose, C. R., Res. Engr., M. P., Houston, Tex. (1948)
Duchac, J. V., Supv. B. & B., C. & N. W., Antigo, Wis. (1927)
Dunnagan, J. P., Engr. of Br., S. P., San Francisco, Calif. (1943)
Duresky, F., Jr., Supv. B. & B., C. & N. W., Huron, S. D. (1942)

E

Eargle, J. M., Mast. Carp., S. A. L., Atlanta, Ga. (1953)
Ebbens, J., Supv. B. & B., C. & W. I., Chicago, Ill. (1947)
Eble, A. E., Const. Engr., St. L. S. W., Naples, Tex. (1953)
Edlund, O. F., Supv. of W. S. & Equip., B. Ry. Co. of C., Chicago, Ill. (1950)
Eichenlaub, C. M., Res. Engr., S. D. & A. E., San Diego, Calif. (1943)
Eitel, R. A., Asst. Supvr. Str., Penna., Cranford, N. J. (1954)
Elliott, C. E., Div. Engr., W. P., Sacramento, Calif. (1950)
Ellis, P. O., Engr. Maint. of W., M. K. T., Dallas, Tex. (1954)
Elower, L., Trav. Br. Insp., Erie, Owego, N. Y. (1948)
Enger, E. M., Supv. B. & B., C. St. P. M. & O., St. Paul, Minn. (1947)
Erickson, H. G., Ch. Engr., L. A. J., Los Angeles, Calif. (1953)
Erickson, O., Asst. B. & B. Supv., S. P., Sacramento, Calif. (1950)
Evans, J. R., Supv. Auto Wk Eqpt., S. P., Tucson, Ariz. (1953)
Everett, P. H., Asst. Supt. Fire Prev., I. C., Chicago, Ill. (1952)

F

Ferguson, J. D., Asst. Div. Engr., C. & O., Hinton, W. Va. (1953)
Ferry, M. H., Mast. Carp., Erie, Hornell, N. Y. (1952)
Firehammer, L. M., Supv. B. & B., Ill. Term., Springfield, Ill. (1919)
Fisher, D. H., Asst. Engr., C. M. St. P. & P., Elmwood Park, Ill. (1952)
Fisher, G. R., B. & B. Mast., C. N., Stratford, Ont., Can. (1949)
Fisk, D. C., Asst. Supv. Str., Penna., Pittsburgh, Pa. (1954)
Fogarty, S., Jr., Asst. Supvr. Trk. & B. & B., C. of G., Columbus, Ga. (1954)
Forseth, C. E., Div. Engr., W. P., Sacramento, Calif. (1950)
Foster, C. B., B. & B. Supv., Sou., Greensboro, N. C. (1954)
Fox, J., B. & B. Mast., C. P., Farnham, Que., Canada (1955)
Fox, R. L., Div. Engr., Southern, Alexandria, Va. (1935)
Fronabarger, H. C., B. & B. Supv., T. & P., Ft. Worth, Tex. (1949)
Frost, L. M., Supv. B. & B., G. T. W., Battle Creek, Mich. (1938)
Fuhr, W. E., Div. Engr., C. M. St. P. & P., Savanna, Ill. (1948)

G

Gabrio, C. W., Br. Engr., Virginian, Norfolk, Va. (1947)
Gannon, J. P., Div. Engr., M. St. P. & S. S. M., Stevens Point, Wis. (1947)
Garcelon, C. E., B. & B. Supt., B. & A., Houlton, Me. (1945)
Garis, L. D., Gen. Br. Insp., C. & N. W., Chicago, Ill. (1930)
Garland, E. F., Br. Supv., N. O. P. B., New Orleans, La. (1953)
Geyer, C. J., Vice Pres., C. & O., Huntington, W. Va. (1928)
Gillespie, W. G., Mast. Carp., B. & O., Grafton, W. Va. (1946)

Gilmore, R. W., Gen. Br. Insp., B. & O., Cincinnati, Ohio (1943)
Gladwin, F. E., B. & B. Supv., N. W. P., San Rafael, Calif. (1950)
Glander, A. M., Ch. Carp., C. M. St. P. & P., Austin, Minn. (1936)
Goforth, J. A., Asst. Engr., Clinchfield, Erwin, Tenn. (1954)
Gossard, J. T., Supv. B. & B., W. M., Hagerstown, Md. (1952)
Graham, W. R., Asst. Supv. B. & B., C. & O., Covington, Ky. (1946)
Granger, R. W., Asst. Engr., A. C. & Y., Akron, Ohio (1953)
Green, C. C., Mast. Carp., B. & O., Wheeling, W. Va. (1953)
Greene, H. P., Supv. Struct., Penna., Philadelphia, Pa. (1947)
Griffis, T. W., B. & B. Insp., N. Y. C. & St. L., Cayuga, Ind. (1954)
Gunderson, R. R., Br. & Struc. Engr., Sys. W. M., Baltimore, Md. (1947)
Gustafson, J. M., Br. Engr., M. & St. L., Minneapolis, Minn. (1949)

H

Haase, E. H., B. & B. Supv., S. P., Oakland Pier #7, Calif. (1954)
Hagenmaier, C. E., Asst. B. & B. Supv., S. P., Los Angeles, Calif. (1950)
Hailey, S. H., Sr. Asst. Engr., N. C. & St. L., Nashville, Tenn. (1948)
Haines, P. D., B. & B. Supv., C. & O., Saginaw, Mich. (1943)
Hall, H. H., Asso. Ed. Ry. Trk. & Str., Chicago, Ill. (1954)
Hall, J. H., B. & B. Supvr., Southern, Valdosta, Ga. (1955)
Hamill, A., B. & B. Mast., E. & N., Victoria, B. C., Can. (1949)
Hamilton, C. W., Engr. of Design, Wabash, St. Louis, Mo. (1950)
Hampton, A. A., Asst. Supv. B. & B., M. P., DeQuincy, La. (1947)
Hancock, J. S., Br. Engr., D. T. & I. R., Dearborn, Mich. (1916)
Hanna, V. C., Ch. Engr., T. R. R. A. of St. L., St. Louis, Mo. (1953)
Hansen, A. E., Ch. Carp., C. M. St. P. & P., Tacoma, Wash. (1954)
Harlow, H. M., Asst. Gen. Supv. B. & B., C. & O., Richmond, Va. (1939)
Harper, W. B., Supv. Trk., I. C., Vicksburg, Miss. (1953)
Harris, A. R., Engr. Br., C. & N. W., Chicago, Ill. (1940)
Hartley, L. M., Mast. Carp., S. A. L., Tampa, Fla. (1949)
Hartman, G. F., Asst. Supv. B. & B., C. & O., Columbus, Ohio (1947)
Harwood, M. S., Sr., Asst. Supvr., B. & B., S. P., San Mateo, Calif. (1948)
Hawkey, W. L., Gen. Fore. B. & B., I. C., Champaign, Ill. (1953)
Hawkins, C. L., Asst. Supv. Structs., Penna., Pittsburgh, Pa. (1950)
Hazer, R. V., Asst. Engr., M. P., St. Louis, Mo. (1954)
Healy, J. J., Asst. Div. Engr., B. & M., Boston, Mass. (1947)
Heck, J. E., Supt. B. & B., C. & O., Ashland, Ky. (1938)
Hecker, R. L., B. & B. & W. S. Supvr., C. & O., Plymouth, Mich. (1947)
Hedley, W. J., Asst. Ch. Engr., Wabash, St. Louis, Mo. (1950)
Hefte, A., Asst. B. & B. Supv., N. W. P., San Rafael, Calif. (1952)
Hellickson, D. E., Mast. Carp., G. N., Whitefish, Mont. (1954)
Hellweg, R. D., Asst. Div. Engr., G. M. & O., Bloomington, Ill. (1947)
Hemmer, A. F., Mast. Carp., C. B. & Q., Brookfield, Mo. (1953)
Hemstad, B., Mast. Carp., G. N., Willmar, Minn. (1937)
Hendrix, W. P., Asst. to Ch. Engr., Penna., Pittsburgh, Pa. (1954)
Hickok, B. M., Supv. B. & B., N. Y. C., Cleveland, Ohio (1951)
Hillman, A. B., Ch. Engr., B. Ry. Co. of C., & C. & W. I., Chicago, Ill. (1942)
Hillman, W. C., Mast. Carp., Clinchfield, Erwin, Tenn. (1953)
Hiner, J. T., B. & B. Supv., Southern, Greenville, S. C. (1950)
Hofstetter, P. W., Asst. B. & B. Supv., M. P., San Antonio, Tex. (1946)
Holmes, E. J., Mast. Carp., Erie, Huntington, Ind. (1952)
Hopton, J. P., Engr. of Maint., C. U. T., Cincinnati, Ohio (1955)
Hornig, F. F., Div. Engr., C. M. St. P. & P., Sioux City, Ia. (1947)
Hotard, A. E., Res. Engr., L. & N., Bay St. Louis, Miss. (1953)
Howard, J. G., B. & B. Insp., W. P., Sacramento, Calif. (1953)
Howard, N. D., Secretary, A. R. E. A., Chicago, Ill. (1926)
Hoyt, A. C., Engr. B. & B., E. J. & E., Joliet, Ill. (1947)
Hubbard, M. J., Gen. Supv. B. & B., C. & O., Richmond, Va. (1948)
Huckaby, V. T., Steel Br. Inspt., M. K. T., Hillsboro, Tex. (1947)
Huckstep, W. A. (Ret.), Gen. Supv. Bldg., Mo. Pac., Tucson, Ariz. (1941)
Huffman, W. H., Asst. Engr. M. of W., C. & N. W., Chicago, Ill. (1941)
Hull, F. G., B. & B. Supv., C. & O., Blenheim, Ont., Can. (1947)
Humphreys, R. W., Asst. Engr., N. P., Pasco, Wash. (1947)
Huntsman, F. C., Asst. Engr., Wabash, St Louis, Mo. (1922)
Huston, P. F., Mast. Carp., C. & S., Denver, Colo. (1948)
Hutcheson, F. W., Supv. B. & B., C. & O., Newport News, Va. (1938)
Hutcheson, W. A., Supv. Wk. Equip., C. & O., Clifton Forge, Va. (1939)

Hutchinson, D. G., B. & B. Insp., W. P., Sacramento, Calif. (1950)

Hutchison, S. N., Engr. Orinoco Mining Co. R. R., New York, N. Y. (1953)

Hutto, J. E., Res. Engr., S. A. L., Savannah, Ga. (1951)

I

Inabinet, J. V., Gen. Br. Insp., S. A. L., Jacksonville, Fla. (1948)

Ingram, J. L., Struc. Drafts., T. R. R. A. of St. L., St. Louis, Mo. (1954)

J

Jackman, H. E., Mast. Carp., B. & O., Chillicothe, Ohio (1944)

Jackson, S. M., Prin. Asst. Engr., M. P., Houston, Tex. (1951)

Jackson, T. E., Gen. B. & B. Supv., S. P., San Francisco, Calif. (1942)

Jarratt, M., W. & F. Supv., S. P., Tucson, Ariz. (1950)

Jenkins, H. W., Asst. Ch. Engr., N. Y., N. H. & H., New Haven, Conn. (1940)

Johns, D. H., Asst. Supv. of Struc., Penna., Buffalo, N. Y. (1953)

Johnson, A. C., Asst. Ch. Engr., E. J. & E., Joliet, Ill. (1944)

Johnson, B. O., Off. Engr., C. M. St. P. & P., Chicago, Ill. (1931)

Johnson, D. H., Supv. B. & B., C. St. P. M. & O., Altoona, Wis. (1940)

Johnson, E. A., Asst. Engr. Br., I. C., Chicago, Ill. (1953)

Johnson, I. K., Ch. Carp., C. M. St. P. & P., Milwaukee, Wis. (1953)

Johnston, C., Div. Engr., L. & N., Birmingham, Ala. (1953)

Johnston, G. H., Gen. For. B. & B., A. T. & S. F., Marceline, Mo. (1950)

Jones, A. C., B. & B. Supv., Southern, Birmingham, Ala. (1938)

Jones, E. B., Br. Insp., C. & O., Clifton Forge, Va. (1945)

Jones, F. Gen. For. B. & B., & W. S., St. L. - S. F., Chaffee, Mo. (1952)

Jorlett, J. A., Asst. Engr. B. & B., Penna., New York, N. Y. (1946)

K

Kaullen, W. C., B. & B. Supv., M. P., Kansas City, Mo. (1953)

Kaylor, F. M., B. & B. Supv., G. S. & F., Valdosta, Ga. (1952)

Kelly, G. E., Asst. Wtr. & Fuel Supv., S. P., Tucson, Ariz. (1953)

Kelly, J. R., B. & B. Supv., Southern, Lexington, Ky. (1952)

Kemmerer, W. G., Asst. Engr. B. & B., Penna., Philadelphia, Pa. (1931)

Kendall, J. T., Gen. Fore. B. & B., Penna., Terre Haute, Ind. (1949)

Kidd, J. W., Asst. Ch. Engr., Southern, Charlotte, N. C. (1954)

Knapp, P., Mast. Carp., Erie, Jersey City, N. J. (1951)

Koehler, P. L., Sup. Simp. Transp. Dept., C. & O., Huntington, W. Va. (1938)

Krefting, A. S., Asst. Ch. Engr., M. St. P. & S. S. M., Minneapolis, Minn. (1935)

Kvenberg, S. E., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1932)

L

Laird, C. W., Scale Supt., M. P., Houston, Tex. (1947)

Lamport, L. R., Ch. Engr. Mtce., C. & N. W., Chicago, Ill. (1935)

Lane, H. W., Rdm., E. J. & E., Joliet, Ill. (1952)

Larson, L. M., Asst. Mast. Carp., G. N., Superior, Wis. (1954)

Laurick, M. J., Gen. Fore. B. & B., Penna., Pittsburgh, Pa. (1952)

Layman, D. C., Gen. B. & B. Fore., I. C., Memphis, Tenn. (1952)

Layman, W. E., Gen. Fore. B. & B., I. C., Carbondale, Ill. (1954)

Leak, V. L., Gen. For. B. & B. & W. S., St. L. - S. F., Tulsa, Okla. (1948)

LeClaire, N. C., Supt. B. & B., T. R. R. A., of St. L., St. Louis, Mo. (1952)

Lederer, C. C., Asst. Engr., N. Y. C., Wayne, Mich. (1949)

Lee, J. D., Asst. Engr., N. Y. C., Detroit, Mich. (1952)

Lehman, H. G., B. & B. Supv., S. P., Tucson, Ariz. (1950)

Leinweber, F. J. A., B. & B. Mast., C. N., St. Thomas, Ont., Can. (1947)

Lieser, H. J., Asst. Rdm., B. R. of C., Chicago, Ill. (1948)

Lingle, T. N., Gen. For. B. & B., I. C., Carbondale, Ill. (1951)

Linn, G. A., Div. Engr., C. & N. W., Chadron, Neb. (1940)

Little, H. C., Supv. of W. S., I. C., Vicksburg, Miss. (1948)

Lokotzke, G. P., Supv. B. & B., E. J. & E., Gary, Ind. (1947)

Loper, L. E., Asst. Mast. Carp., Erie, Hornell, N. Y. (1951)

Lorber, R. J., Supv. B. & B., P. & P. U., Peoria, Ill. (1948)

Lord, H. T., B. & B. Mast., C. P., Kenora, Ont., Can. (1940)

Lorence, H. B., Fire Prot. Engr., C. R. & I., (Gibson,) Hammond, Ind. (1950)

Lowry, J. M., Ch. Engr., St. L. S. W., Tyler, Tex. (1950)

Lucas, H. F., Detailer, C. M. St. P. & P., Chicago, Ill. (1952)

Luce, W. L., Mast. Carp., Erie, Youngstown, Ohio (1952)

Luck, R. P., Draftsman, C. & N. W., Chicago, Ill. (1920)

Lucy, J. M., B. & B. Supv., D. & H., Plattsburgh, N. Y. (1953)

Lund, C. V., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1947)

Lyman, V. W., Supv. B. & B., C. V., St. Albans, Vt. (1953)

Lyon, L. E., Div. Engr., S. P., El Paso, Tex. (1947)

Mc

*McCallum, S. L., Arch. Designer, M. C., Detroit, Mich. (1952)

McCauley, M. L., Dist. Engr. Str., N. Y. C., Cleveland, Ohio (1950)

McDermott, A. A., B. & B. Supv., S. P., Dunsmuir, Calif. (1945)

McDonald, J. W., Gen. For. B. & B. & W. S., St. L. - S. F., Springfield, Mo. (1947)

McElreath, C. S., B. & B. Supv., Southern, Chattanooga, Tenn. (1951)

McEwen, R. G., B. & B. Supv., Mo. Ill., Ste. Genevieve, Mo. (1952)

McGee, M. A., Div. Engr., L. & N., Ravenna, Ky. (1954)

McGrew, B. H., Supv. B. & B., St. L. S. W. of T., Tyler, Tex. (1951)

McGrew, F. O., Ch. Carp, C. M. St. P. & P., Terre Haute, Ind. (1948)

McKibben, D. H., Supvr. Str., P. R. R., Columbus, Ohio (1951)

McLeod, C. A., Asst. Supt., St. L.-S. F., Newburg, Mo. (1953)

McMillen, J. W., Off. Engr., T. R. R. A. of St. L., St. Louis, Mo. (1954)

McNally, P. F., B. & B. Supv., S. P., Ogden, Utah (1948)

M

MacDonald, J. J., Asst. Supv. B. & B., B. & M., Boston, Mass. (1951)

Madson, H. C., Designer, C. & N. W., Chicago, Ill. (1940)

Manley, B. F., Supv. B. & B., P. E., Los Angeles, Calif. (1943)

Manning, D. A., Supv. B. & B., C. & N. W., Chicago, Ill. (1939)

Marshall, R. B., Asst. Engr., C. & O., Richmond, Va. (1949)

Martens, W. F., Gen. For. B. & B., A. T. & S. F., San Bernardino, Calif. (1924)

Martin, J. G., Jr. Engr., St. L.-S. F., Springfield, Mo. (1954)

Martin, J. W., Asst. Mast. Carp., S. A. L., Jacksonville, Fla. (1953)

Martin, S. L. Asst. B. & B. Supv., T. & N. O., LaFayette, La. (1951)

Martin, T. J., Gen. Mast. Carp., G. N., Seattle, Wash. (1940)

Mason, E. L., B. & B. Supv., M. P., Kingsville, Tex. (1946)

Mason, S. K., Ch. Engr., T. M., Laredo, Tex. (1950)

Mateer, W. G., Mgr. of Pur. & Stores, E. J. & E., Chicago, Ill. (1944)

Mathis, R. C., Br. Insp., I. C., Memphis, Tenn. (1947)

Matthews, H. A., Gen. For. B. & B. & W. S., St. L. - S. F., Amory, Miss. (1949)

Matthews, W. L., Sr. Asst. B. & B. Supv., S. P., Tucson, Ariz. (1953)

May, L. E., B. & B. For., A. T. & S. F., Fresno, Calif. (1948)

Mayfield, L., Res. Engr., Mo. Pac. Lines, Houston, Texas (1944)

Mays, J. W. N., Supv. Str., Penna., Pittsburgh, Pa. (1947)

Meeks, W. R., B. & B. Supv., M. P., Falls City, Neb. (1942)

Meredith, W. E., Supv. Struct., Penna., Indianapolis, Ind. (1950)

Merrill, B. W., Supv. B. & B., N. Y. C. & St. L., Conneaut, Ohio (1936)

Meserve, E. S., Supv. B. & B., B. & M., Dover, N. H. (1949)

Messman, D. V., Engr. of Bdgs., Southern, Knoxville, Tenn. (1955)

Meyers, B. R., Ch. Engr., C. & N. W., Chicago, Ill. (1930)

Midkiff, R. B., Ch. Engr., M. W. & S., Sou., Knoxville, Tenn. (1953)

Miesenhelder, P. D., Concrete Engr. Research Staff - A.A.R., Chicago, Ill. (1952)

Miller, R. H., Asst. Engr., B. & A., Houlton, Me. (1953)

Miller, R. S., Bldg. Supt., C. R. I. & P., Chicago, Ill. (1949)

Milne, A. P., Supv. B. & B., N. Y. C. & St. L., Frankfort, Ind. (1953)

Mitchell, D. N., Asst. Supv. B. & B., C. & O., Newport News, Va. (1948)

Montague, C. F., Asst. Engr., Penna., Philadelphia, Pa. (1953)

Moore, A. J., Br. Insp., M. P., Eunice, La. (1950)

Moore, H. S., B. & B. Mast., C. P., Revelstoke, B. C. Can. (1954)

Moore, I. A., Ch. Engr., C. & E. I., Danville, Ill. (1937)

Moore, J. D., Supv. Struc., Penna., Pittsburgh, Pa. (1953)

Moreland, H. B., B. & B. Supv., Southern, Wilton, Ala. (1951)

Morgan, C. E., Asst. B. & B., T. & N. O., San Antonio, Tex. (1954)

Morgan, J. H., Engr. M. of W., F. E. C., St. Augustine, Fla. (1948)

Morgan, L. R., Fire Prot. Engr., N. Y. C., Detroit, Mich. (1937)

Morrison, R. H., Ch. Engr., B. & A., Houlton, Me. (1941)

Moser, C. A., B. & B. Supv., S. N., Sacramento, Calif. (1951)

Mottier, C. H., Vice Pres. & Ch. Engr., I. C., Chicago, Ill. (1942)

Mouhot, P. T., B. & B. Supv., T. & N. O., Lafayette, La. (1952)

Murray, D. I., Engr. Dftsman, C. & W. I.-B. Ry. of C., Chicago, Ill. (1954)

Myers, R. L., Supv. W. S., I. C., Clarksdale, Miss. (1950)

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*Junior Member

N

Neal, G. W., Supt., Chattahoochee Valley, West Point, Ga. (1948)

Nicely, O. P., Asst. Supv. B. & B., C. & O., Clifton Forge, Va. (1950)

Nichols, J. C., Br. Engr., L. & N., Louisville, Ky. (1954)

Norris, H. Asst. Supv. B. & B., F. E. C., Miami, Fla. (1948)

Norris, J. M. W., B. & B. Supv., D. & H., Oneonta, N. Y. (1952)

Norton, R. L., Mast. Carp., S. A. L., Savannah, Ga. (1951)

Nuckols, L. T., Ch. Engr., C. & O., Richmond, Va. (1951)

O

O'Brien, J. B., Asst. Supvr. B. & B., C. & O., Richmond, Va. (1954)

Odgers, F. T., Asst. B. & B. Supvr., S. P., Portland, Oreg. (1955)

Oest, W. C., Prin. Asst. Engr., Ft. W. & D., Ft. Worth, Tex. (1947)

Olson, O. D., B. & B. Supv., C. & N. W., Chicago, Ill. (1953)

Olson, V. E., B. & B. Supv., M. St. P. & S. S. M., Stevens Point, Wis. (1948)

Ornburn, B. J., Asst. Ch. Engr. Struct., C. M. St. P. & P., Chicago, Ill. (1948)

Ostrom, W. D., Ch. Carp., C. M. St. P. & P., Miles City, Mont. (1954)

Ovardits, K., Asst. Engr., N. Y. C., Chicago, Ill. (1953)

P

Packard, B. G., Office Engr., C. & N. W., Chicago, Ill. (1954)

Pahl, W. H., Jr., Asst. Supv. Strucs., Penna., Indianapolis, Ind. (1950)

Park, E., Jr., Draftsman, M. P., Houston, Tex. (1948)

Parrish, E. L., Div. Engr., I. C., Vicksburg, Miss. (1947)

Patrick, F. V., B. & B. Supv., Southern, Knoxville, Tenn. (1954)

Patterson, C. A., B. & B. Supvr., T. P. & W., Washington, Ill. (1955)

Patterson, R. H., B. & B. Supvr., St. L. S. W., Pine Bluff, Ark. (1955)

Paulson, R. E., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1945)

Pearson, A. H., Mast. Carp., C. B. & Q., St. Joseph, Mo. (1952)

Peden, J. S., W. S. Supv., T. & P., Big Spring, Tex. (1953)

Pederson, W. E., B. & B. Supv., M. St. P. & S. S. M., Superior, Wis. (1950)

Peek, J. M., B. & B. Supv., Southern, Greenville, S. C. (1951)

Penhallegon, J. R., Asst. Supv. B. & B., C. & N. W., Chicago, Ill. (1940)

Perrier, J. L., Div. Engr., C. & N. W., Chicago, Ill. (1953)

Perrine, D. E., Asst. Ch. Engr., C. & W. I., Belt Ry. Co. of Chgo., Chicago, Ill. (1953)

Perry, C., Asst. Supv. B. & B., C. & O., Ashland, Ky. (1950)

Peterson, H. R., Ch. Engr., N. P., St. Paul, Minn. (1953)

Peterson, J. C., Sr. Asst. B. & B. Supv., S. P., Sacramento, Calif. (1950)

Peterson, J. E., Off. Engr., C. & W. I. & B. Ry. Co. of C., Chicago, Ill. (1952)

Peterson, N. E., Ch. Engr., C. & I. M., Springfield, Ill. (1938)

Petteys, W. F., Div. Engr., Erie, Hornell, N. Y. (1948)

Pfeiffer, A., Asst. B. & B. Supv., S. P., Sacramento, Calif. (1939)

Phelps, C. E., B. & B. Supvr., Ga., A. & W. P., & W. of A., Camak, Ga. (1949)

Phillips, B. C., Mast. Carp., C. B. & Q., Alliance, Neb. (1947)

Phillips, E. L., Mast. Carp., C. B. & Q., Casper, Wyo. (1953)

Piepmeier, A. L., Br. Engr., C. G. W., Oelwein, Ia. (1953)

Pierce, G. A., Mast. Carp., B. & O., Halethorpe, Md. (1953)

Podas, N. F., Ch. Engr., St. P. U. D. Co. & M. T. Ry. Co., St. Paul, Minn. (1937)

Pound, E. R., Mast. Carp., B. & O., Newark, Ohio (1952)

Preston, C. W., Engr. Prot. Coatings, B. & O,. Baltimore, Md. (1950)

Price, A. C., B. & B. Master, C. P., London, Ont., Can. (1953)

Priest, G. H., Gen. For. B. & B., C. N., Belleville, Ont., Can. (1948)

Prude, G. F., Supv. B. & B., T. & N. O., Houston, Tex. (1951)

Pryor, W. H., Gen. For. B. & B. & W. S., St. L. - S. F., Memphis, Tenn. (1946)

Pyle, T. V., Engr. of Design, E. J. & E., Joliet, Ill. (1954)

R

Raessler, V. D., Supv. B. & B., I. C., Memphis, Tenn. (1951)

Raley, W. F., Mast. Carp., B. & O., Callery, Pa. (1949)

Rapier, L. F., Supv. B. & B., G. M. & O., Bloomington, Ill. (1946)

Rasmussen, L. B., Asst. Supvr. Str., P. R. R., New York, N. Y. (1954)

Raver, H. E., Engr. of Struc., L. I., Jamaica, N. Y. (1952)

Reed, F. A., Supv. B. & B., I. C., Clinton, Ill. (1947)

Reed, T. C., Supv. B. & B., L. & N., Ravenna, Ky. (1954)

Reese, C. M., Gen. Fore. B. & B., G. C. & S. F., Temple, Tex. (1953)

Rice, E. D., B. & B. Supv., C. & E. I., Danville, Ill. (1949)

Richardson, H. B., B. & B. Supv., B. & M., Dover, N. H. (1948)

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Robbins, C. W., Dist. Engr., M. K. T., Smithville, Tex. (1954)

Roberts, H. L., Br. Insp., C. & O., Royal Oak, Mich. (1952)

Robertson, J. H., Asst. Engr., M. P., Houston, Tex. (1953)

Robinson, G. E., Engr. Struct., N. Y. C. Sys., Chicago, Ill. (1948)

Robinson, N. R., B. & B. Supv., S. P., Sacramento, Calif. (1934)

Rode, L. A., Gen. Br. Insp., Erie, Newark, N. J. (1948)

Routenberg, H. W. (Retired), Mast. Carp., B. & O., Baltimore, Md. (1946)

Russell, C. E., Supv. W. S., I. C., Chicago, Ill. (1953)

S

Safley, J. R., B. & B. Supv., S. P., San Mateo, Calif. (1945)

Salmon, J. M., Jr., Ch. Engr., Clinchfield, Erwin, Tenn. (1938)

Sathre, C. O., B. & B. Supv., C. & N. W., Madison, Wis. (1950)

Saunders, H. M., Supv. B. & B., C. & O., Richmond, Va. (1954)

Saunders, T. D., Ch. Engr., O. N., North Bay, Ont., Can. (1930)

Saurer, D. E., Asst. Supv. Struct., Penna., Logansport, Ind. (1951)

Sawyer, J. H., Jr., Ch. Engr., C. G. W., Oelwein, Ia. (1951)

Scheumack, J. F., Br. Engr. & Insp., T. & N. O., Houston, Tex. (1950)

Schlaf, E. R., Asst. Supt. W. S., I. C., Chicago, Ill. (1947)

Schmidl, R. M., Ed. Prod., Simmons Boardman Pub. Corp., New York, N. Y. (1952)

Schneider, J. C., B. & B. Supv., T. & N. O., Victoria, Tex. (1950)

Schroeder, A. W., Vice Pres. & Gen. Mgr., C. & E. I., Chicago, Ill. (1949)

Scites, P. E., Supv. B. & B., C. & O., Huntington, W. Va. (1950)

Scroggin, D. R., Jr., Engr., C. S. S. & S. B., Michigan City, Mich. (1953)

Seals, R. K., Div. Engr., Southern, Greensboro, N. C. (1951)

Seley, L. L., Mast. Carp., C. B. & Q., Hannibal, Mo. (1953)

Seltzer, H. A., B. & B. Supv., N. P., Missoula, Mont. (1953)

Shaefer, L. A., Supv. W. S., M. P., Osawatomie, Kan. (1948)

Sharkey, J. J. (Retired), Gen. For. B. & B., Penna., Bradley Beach, N. J. (1951)

Shepley, S. H., Ch. Engr., E. J. & E., Joliet, Ill. (1945)

Shirey, L. L., Br. Engr., C. & O., Richmond, Va. (1954)

Shobert, F., Sys. Steel Constr. For., S. P., Oakland, Calif. (1918)

Short, J. M., Gen. W. S. Insp., T. & P., Dallas, Tex. (1950)

Short, W. L., Br. Insp., M. P., St. Louis, Mo. (1951)

Shryer, L. S., Asst. Gen. Fore. B. & B., A. T. & S. F., Winslow, Ariz. (1954)

Siegfried, F. A., For. Carp., Reading, Reading, Pa. (1947)

Simpson, P. X., Supv. B. & B., N. P., Tacoma, Wash. (1953)

Sinclair, C. H., Asst. Supv. B. & B., C. & N. W., Milwaukee, Wis. (1954)

Skinner, H. E., Supv. Scales & Wk. Equip., E. J. & E., Joliet, Ill. (1944)

Slagle, G. P., Ch. Carp., C. M. St. P. & P., Milwaukee, Wis. (1948)

Smith, A. E., Dist. Engr., M. K. T., Parsons, Kans. (1954)

Smith, C. A., Supv. B. & B., C. R. & I. and I. H. B., Hammond, Ind. (1946)

Smith, E. L., B. & B. Supv., Southern, Hattiesburg, Miss. (1952)

Smith, H. E., Engr. M. of W., G. H. & H., Galveston, Tex. (1941)

Smith, J., B. & B. Supv., S. P., Sacramento, Calif. (1943)

Smith, J. G., Asst. Supv., B. & B., C. & O., Clifton Forge, Va. (1953)

Smith, L. C. (Retired), Div. Engr., C. & N. W., Eagle Grove, Ia. (1942)

Smith, L. L., Asst. B. & B. Supv., S. P., Dunsmuir, Calif. (1948)

Smith, N. E., Div. Engr., C. M. St. P. & P., Chicago, Ill. (1951)

Snyder, E. F., Asst. to Ch. Engr., I. C., Chicago, Ill. (1948)

Sparks, F. P., Br. Insp., N. Y. C., Mattoon, Ill. (1954)

Spofford, F. R., Asst. to Ch. Engr., B. & M., Boston, Mass. (1940)

Sprengel, H. A., Asst. B. & B. Supv., M. P., Falls City, Nebr. (1950)

Steel, J. V., Engr., Acct., U. T. Co., Dallas, Tex. (1953)

Stephens, B. M., Asst. Ch. Engr., T. & N. O., Houston, Tex. (1946)

Stephens, O. W., Asst. to Ch. Engr. Mtce., D. & H., Albany, N. Y. (1929)

Stevens, C. M., B. & B. Supv., S. P., Portland, Ore. (1950)

Stinebaugh, J. H., Supv. W. S., I. C., Carbondale, Ill. (1951)

Strouss, J. A., Asst. Supv. B. & B., S. P., Sacramento, Calif. (1934)

Stutzman, J. W., Fore. Carp., Reading, Reading, Pa. (1951)

Sumner, J., W. S. For., St. L. - S. F., Springfield, Mo. (1948)

Swanson, M., Insp. B. & B., D. T. & I., Dearborn, Mich. (1953)

Sweet, W. A., Gen. For. B. & B., A. T. & S. F., Newton, Kan. (1928)

Switzer, G., Gen. Supv. Str. & Wk. Equip., W. P., Oakland, Calif. (1949)

Switzer, R. E., Gen. For. B. & B. & W. S., G. C. & St. F., Galveston, Tex. (1952)

T

Taggart, C. R., Supv. B. & B., N. Y. C., Indianapolis, Ind. (1935)

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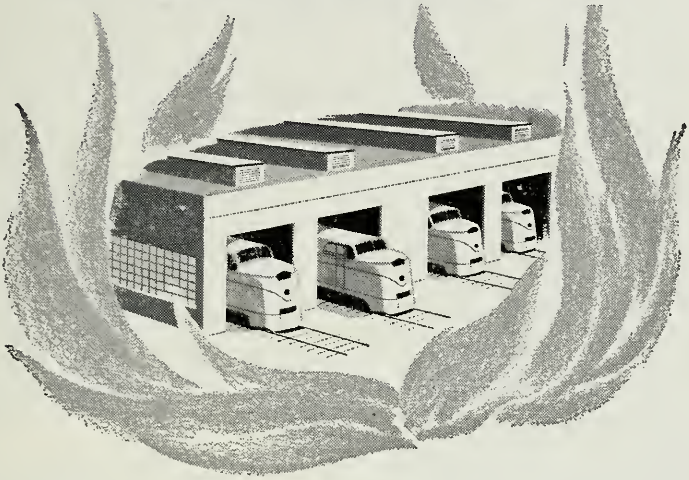

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Taylor, F. H., Asst. Engr. M. of W. Dept., F. E. C., St. Augustine, Fla. (1951)

Taylor, W. L., B. & B. Supv., Southern, Jasper, Ala. (1950)

Templin, R. S., For. Carp., Reading, St. Clair, Pa. (1947)

Tetreault, L. J., B. & B. Fore., N. Y., N. H. & H., Providence, R. I. (1936)

Thelander, P. V., Asst. Ch. Engr., C. & N. W., Chicago, Ill. (1939)

Todd, D. C., Asst. Engr., Penna., Pittsburgh, Pa. (1942)

Todd, J. N., Supt. Scales & Wk. Eqpt., Sou., Washington, D. C. (1953)

Tourtellotte, E. B., Supv. B. & B., B. & M., Greenfield, Mass. (1947)

Towle, W. T., Supv. B. & B., N. Y. C. & St. L., Brewster, Ohio (1954)

Trulove, J. D., Sr. Asst. B. & B. Supv., S. P., Ogden, Utah (1945)

Tucker, N. R., Asst. Div. Engr., T. & N. O., Houston, Tex. (1939)

Tunison, H. C., Asst. Engr. M. of W., L. & N. E., Bethlehem, Pa. (1946)

Tupper, A. E., B. & B. For., S. P., Stockton, Calif. (1942)

Turner, E. F., For. Steel Const., M. K. T. & M. K. T. of T., Denison, Tex. (1950)

Tyckoson, E. G., Asst. Ch. Carp., C. M. St. P. & P., Chicago, Ill. (1954)

V

Van Ness, R. A., Br. Engr. Sys., A. T. & S. F., Chicago, Ill. (1949)

Varker, J. L., Div. Engr., D. & H., Carbondale, Pa. (1936)

von Sprecken, R. E., Trk. Supv., Southern, Winston Salem, N. C. (1951)

von Sprecken, T. M., Asst. to Ch. Engr., Southern, Washington, D. C. (1938)

W

Walker, G. P., Supv. B. & B., M. P., Monroe, La. (1929)

Wall, E. G., Div. Engr., G. M. & O., Bloomington, Ill. (1942)

Wall, R., Supv. B. & B., Southern, Selma, Ala. (1948)

Wallace, C. E., Gen. For. B. & B. & W. S., St. L. - S. F., Ft. Smith, Ark. (1948)

Wang, A. B., Supv. B. & B., C. I. & L., Lafayette, Ind. (1950)

Ward, W. G., Asst. Supv. B. & B., C. & N. W., West Chicago, Ill. (1952)

Warfield, H., Jr., Insp. M. of W., Penna., New Brunswick, N. J. (1952)

Warfield, W. B., Supv. Str., Penna., Pittsburgh, Pa. (1951)

Warner, B. I., Asst. Supv. B. & B., Me. Cent., Portland Me. (1952)

Warrenfells, J. F., Asst. Div. Engr., S. A. L., Raleigh, N. C. (1946)

Weatherly, H. E., Asst. Div. Engr., T. & N. O., El Paso, Tex. (1950)

Weaver, W. R., Supt. M. P. & Equip. & Ch. Engr., P. & S., Brookvale, Pa. (1951)

Webber, G. R., Ch. Carp., C. M. St. P. & P., Spokane, Wash. (1948)

Welch, J. W., Supv. B. & B., F. E. C., St. Augustine, Fla. (1943)

White, L. H., Supv. B. & B., I. C., New Orleans, La. (1946)

White, S., Gen. B. & B. Supv., S. P., San Francisco, Calif. (1942)

Whitehouse, B. M., Ch. Fire Insp., C. & N. W., Chicago, Ill. (1927)

Widrig, F. F., Asst. Engr., N. Y. C., Detroit, Mich. (1949)

Wiitala, A., Gen. For. B. & B., L. S. & I., Marquette, Mich. (1941)

Williams, C., Asst. Supv. B. & B., C. & O., Ashland, Ky. (1950)

Williams, L. L., B. & B. Supv., L. & N., Birmingham, Ala. (1953)

Williams, N. H., B. & B. Mast., D. & H., Oneonta, N. Y. (1947)

Wilson, H. M., Asst. Supv. Struc., Penna., Columbus, Ohio (1953)

Wilson, R. P., Supv. B. & B., C. & O., Hinton, W. Va. (1948)

Winkelhaus, L. C., Asst. Arch. Engr., C. & N. W., Chicago, Ill. (1934)

Wintoniak, S. G., Supv. of Struc., Penna., Altoona, Pa. (1953)

Wistrich, H. A., Asst. Ch. Engr., L. V., Bethlehem, Pa. (1938)

Witherspoon, J. P., Mast. Carp., S. A. L., Savannah, Ga. (1948)

Wood, R. E., Mast. Carp., G. N., Great Falls, Mont. (1954)

Woodward, J. D., Asst.Supv. Strucs., Penna., Pittsburgh, Pa. (1952)

Woolford, F. R., Ch. Engr., W. P., San Francisco, Calif. (1950)

Worden, R. K., Gen. Fore. B. & B. & W. S., G. C. & S. F., Ft. Worth, Tex. (1954)

Wray, H. O., Sec. & Ch. Engr., T. C. Term., Texas City, Tex. (1939)

Wrights, H., Supv. B. & B., M. P., Little Rock, Ark. (1929)

Y

Yaw, D. M., Mast. Carp., Erie, Buffalo, N. Y. (1951)

Yewell, J. E., Ch. Engr., B. & L. E., Greenville, Pa. (1941)

Z

Zapfe, E. J., Asst. Ch. Engr. & Supt. B. & B., G. B. & W., Green Bay, Wis. (1952)

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B

Batey, W. A., (Ret.), Const. Engr., U. P., 4303 South St., Lincoln Neb. 1918
Benjamin, H. I., (Ret.), Vice Chair. Sys. Com. on Ins., S. P., San Francisco, Calif. 1922
Bost, M. A., (Ret.), Asst. Engr., C. M. St. P. & P., Mason City, Iowa 1935

C

Church, H. M., (Ret.), Gen. Supvr. B. & B., C. & O., 509 No. Blvd., Richmond, Va. 1939
Clark, W. A., (Ret.), Off. Engr., D. M. & I. R., 2718 E. 5th St., Duluth 5, Minn. 1908
Corey, S. T., (Ret.), Off. Engr. & Engr. of Br., C. R. I. & P., 7250 Harvard Ave., Chicago 21, Ill. 1913
Cota, G. M., (Ret.), Ch. Clk. Engr. Dept., C. of V., Box 114, St. Albans, Vt. 1913
Cramer, F. H., (Ret.), B. & B. Engr., C. B. & Q., Chicago, Ill. 1927

D

Decker, H. H. (Ret.), Engr. of M., C. & N. W., 2915 Ingersoll Ave., Des Moines, Ia. 1908

E

Eisele, C., (Ret.), Asst. Engr., N. Y. C., Cleveland, Ohio 1930
Engman, V. E., (Ret.), Ch. Carp., C. M. St. P. & P., 3429 - 17th Ave., So., Minneapolis 7, Minn. 1920

F

Flynn, M. J., (Ret.), Supvr. B. & B., C. & N. W., 2445 Coyle Ave., Chicago 45, Ill. 1905

G

Gehr, B. F., (Ret.), Mast. Carp., Penna., 400 So. 14th St., Richmond, Ind. 1908
Gentis, I., (Ret.), Fore. B. & B., S. P., 2003 West St., Oakland, Calif. 1912
Gerst, H. A., (Ret.), Asst. Engr., G. N., 748 Aldine St., St. Paul 4, Minn. 1917
Gillette, J. E., (Ret.), Carp. Fore., C. M. St. P. & P., c/o Carp. Fore., C. M. St. P. & P. Mazomanie, Wis. 1923
Gillis, A. D., (Ret.), B. & B. Supvr., N. Y. N. H. & H., c/o B. & B. Supvr., N. Y., N. H. & H., Providence, R. I. 1923
Gunderson, E., (Ret.), Supt. B. & B., C. St. P. M. & O., Altoona, Wis. 1927
Guppy, B. W., (Ret.), Engr. Strucs., B. & M., 52 Stratford Rd., Melrose, Mass. 1914

H

Hand, G. W., (Ret.), Asst. to Pres., C. & N. W., 412 Courtland Ave., Park Ridge, Ill. 1909
Harman, W. C., (Ret.), Supv. B. & B., S. P., 656 Cedar St., San Carlos, Calif. 1911
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Hillman, F. W., (Ret.), Asst. Engr. M. of W., C. & N. W., 1452 Oak Ave., Evanston, Ill. 1917
Hofacker, J. P., (Ret.), Supvr. B. & B., L. V., 54 No. Fulton St., Auburn, N. Y. 1907
Horning, H. A., (Ret.), Asst. Supt. Br., M. C., 1106 Francis St., Jackson, Mich. 1902
Howay, B. J., (Ret.), Supvr. B. & B. - W. S., C. & O., 403 No. Bridge, Grand Ledge, Mich. 1919

J

Johnson, M., (Ret.), Prin. Asst. Engr., I. C., c/o Casa de Fresa., Hammond, La. 1915

K

Kimball, L. P., (Ret.), Engr. Bldgs., B. & O., 5910 S. W. 50th St., Miami 34, Fla. 1921
Koch, H. L., (Ret.), Supvr. B. & B., N. Y. C. & St. L., 637 Main St., Conneaut, Ohio . . . 1922

L

Lacher, W. S., (Ret.), Secretary, A. R. E. A., 407 E. Fuller Rd., Hinsdale, Ill. 1922
Lacy, W. J., (Ret.), Supvr. B. & B., M. P., 4370 Swan St., St. Louis, Mo. 1911
Lampson, W., (Ret.), Supv. B. & B., M. C., 242 St. John St., Portland, Me. 1930
Landstrom, C. A., (Ret.), Supvr. B. & B., C. B. & Q., 1311 S. 3rd St., Burlington, Ia. . . 1928
Larsen, H. C., (Ret.), Str. Iron Fore., C. St. P. M. & O., 1084 Sims Ave., St. Paul 6, Minn. 1928
Lincoln, S., (Ret.), Gen. Fore. B. & B., G. C. & S. F., 1903 Harrison Ave., Beaumont, Tex. 1927

Mc

McCabe, E. M., (Ret.), Supvr. B. & B., B. & A., Rte. 44, Narrangansett Ave., Pittsfield, Mass. 1915
McKay, A. G., (Ret.), Supvr. B. & B., N. Y., N. H. & H., 11 Pine Island Road, Jupiter Pt. Groton, Conn. 1915
McMahon, T. D., (Ret.), Arch., G. N., 223 Lake Avenue, White Bear Lake 10, Minn. . . 1918
McNaughton, H. C., (Ret.), Supvr. B. & B., B. & M., c/o Supvr. B. & B., B. & M., Greenfield, Mass. 1915

M

Masters, F. H., (Ret.), Spec. Engr., E. J. & E., 907 Glenwood Ave., Joliet, Ill. 1920
Mead, E. L., (Ret.), Div. Engr., C. & N. W., 536 N. E. 69th St., Miami, Fla. 1923
Mellgren, J., (Ret.), Fore. W. S., C. & N. W., 523 N. Cadwell Ave., Eagle Grove, Ia. . . 1913
Merwin, P. B., (Ret.), Asst. Engr., C. & N. W., Rte. 2, Box 565, Washougal, Wash. . . . 1929
Miller, C. E., (Ret.), Asst. Engr. M. of W., C. & N. W., 251 Woodland Rd., Highland Pk., Ill. 1916

N

Nies, A. B. (Ret.), Arch., N.Y.C.System, 408 Third St., Jackson, Mich. 1915

O

O'Brien, W. J., (Ret.), Dist. Carp., C.M.St.P. & P., Juneau County, Necedah, Wis. 1919

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Patenaude, E., (Ret.), B. & B., C. P., 133 John St., Sturgeon Falls, Ont., Can.	1930
Phillips, W. J., (Ret.), Asst. Gen.Br.Insptr.,S.P., 318 Arlington Ave., Berkeley, Calif.	1925
Piccone, C., (Ret.), Br. Engr., Nat.Rys. of Mex., Monte Everest 210, Lomas de Chapultepec, Mexico City, Mex.	1923
Pinard, T. W., (Ret.), Ch. Engr., L. I., 9 Broadview Ave., Box 692, Bellport, L. I., N. Y.	1920
R	
Reece, A. N., (Ret.), Asst. to Pres., K. C. S., 114 W. 11th St., Kansas City, Mo.	1922
Rehmert, D. L. (Ret.), Mast. Carp., Penna., 376 Chitteden Ave., Columbus, Ohio	1918
Richards, C. A. J., (Ret.), Asst. Supvr. Strucs., Penna., 422 Gladstone Ave., S.E. Grand Rapids, Mich.	1924
Rights, H. T., (Ret.), Asst. Br. Engr., L. V., 1015 Raymond Ave., Bethlehem, Pa.	1927
Rintoul, D. T., (Ret.), Gen. Br. Inspr., S. P., 2571 Glen Green, Hollywood 28, Calif.	1910
Roof, W. R., (Ret.), Br. Engr., C. G. W., 7728 So. Yates Ave., Chicago 49, Ill.	1927
Rowland, O. F., (Ret.), Asst. Engr., D. & H., c/o Berkshire Industrial Farm, Canaan, N. Y.	1923
S	
Scheetz, F. B., (Ret.), Asst. Engr., M. P., 3930 Connecticut Ave. N.W., Washington, D. C.	1905
Singer, E. W., (Ret.), Supv. B. & B., N. Y. C. & St. L., 2125 Owaissa Way, Ft. Wayne, Ind.	1923
Smith, C. E., (Ret.), Vice Pres., N.Y. N.H. & H., 282 Prospect St., New Haven, Conn.	1911
Stuart, H. B., (Ret.), Struc. Engr., G. T., 4205 Dorchester St., Westmount, P.Q., Can.	1913
Swartz, W. G., (Ret.), Engr. Acct., C. N., Box #2096 - San Juan Ave., Victoria, B. C., Can.	
T	
Tattershall, E. R., (Ret.), Supvr. of Mtce. Equip., N.Y.C., 21 Coy St., Malone, N. Y.	1913
V	
Vance, W. H., (Ret.), Asst. Engr. M. of W., M.P., 6347 Alamo Ave., Clayton 5, Mo.	1910
Von Schrenk, H., Cons. Tbr. Engr., M. P., 289 St. Denis St., Florrissant, Mo.	1916
W	
Wait, R. E., (Ret.), Supv. B. & B., Wabash, 1638 N. Maple, Decatur, Ill.	1923
Walden, W. H., (Ret.), Rdm., Southern, 1012 Porter St., Richmond 24, Va.	1920
White, W. E., (Ret.), Gen. Fore., A.T.&S.F., 706 W. 6th St., Chanute, Kan.	1920
Womeldorf, C. F., (Ret.), Div. Engr., C. & N.W., 111 No. 12th St., Norfolk, Nebr.	1917
Wright, C. W., (Ret.), Mast. Carp., L.I., 67 Nassau Pkwy., Oceanside, N. Y.	1908
Wuerth, H., (Ret.), Div. Engr. C.M.St.P.&P., Savanna, Ill.	1919
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Zinsmeister, E. C., (Ret.), Mast. Carp., B. & O., 303 - 12th Ave. No., St. Petersburg, Fla.	1905

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Baker, D. L., Vice Pres. & Treas., Baker & Hickey Co., P.O. Box 5008, Tri Village Sta. Columbus 12, Ohio	1946
Bauman, K. F., Vice Pres. - Sls., Warren Tool Corp., Warren, Ohio	1952
Bishop, D. B., Dist. Mgr., Dearborn Chemical Co., 1514 Farmers Bank Bldg., Pittsburgh 22, Pa.	1946
Bolton, J. D., President, John D. Bolton & Co., Gunite Contractor, 910 Custer Ave., Evanston, Ill.	1946
Borcherding, C. H., Dist. Mgr., The Master Bldrs. Co., 2125 Maryland Ave., Baltimore, Md.	1947
Boulton, C. R., R. R. Contractor, 10 E. Town St., Columbus 15, Ohio	1946
Brennon, L. D., M. of W. Instr., Air Reduction Sales Co., 620 King Drive, Pine Lake, Ga.	1950
Bryant, C. E. Jr., Johns-Manville Sls. Corp., 22 E. 40th St., New York, N. Y.	1951
Burkey, J. R., Const. Engr., The Union Metal Mfg. Co., 2421 Plymouth Ave., Columbus, Ohio	1942
Burpee, C. M., Mgr. Service Bureau, American Wood Preservers Assn., 111 W. Washington St., Chicago, Ill.	1930
Buskirk, G. C., Mgr. Ry. Div., Pacific Coast Borax Co., 916 WOW Bldg., Omaha, Nebr.	1949
C	
Canning, J. F., Pres., Southwestern Petroleum Co., Inc., P. O. Box 789, Ft. Worth, Tex.	1949
Clapp, K. J., Asst. Sls. Mgr., Homelite Corp., Port Chester, N. Y.	1946
Clark, H., Jr., Mgr. R. R. Sls., Armco Drainage & Metal Products, Inc., 310 S. Michigan Ave., Chicago, Ill.	1953
Clarke, R., Res. Mgr., Massey Concrete Products Co., 111 W. Washington St. Chicago 2, Ill.	1948
Clegg, R. R., Dist. Sales Mgr., American Lumber & Treating Co., Rm. 2040 - 122 So. Michigan Ave., Chicago, Ill.	1946
Collette, D. W., Fld. Engr., H. H. Robertson Co., 221 N. LaSalle St., Chicago, Ill.	1953
Colvin, C. M., Ry. Sls. Engr., Armco Drainage & Metal Prod., Inc., 7th & Parker Sts., Berkeley, Calif.	1945
Cottier, E. F., Sls., Pacific Coast Borax Co., Auburn, Ala.	1953
Cross, E. T., Vice Pres., Armco Drainage & Metal Prod. Inc., Middletown, Ohio	1946
Crowe, J. A., Mgr., Bird Tie Pads, Bird & Son, Inc., East Walpole, Mass.	1951
D	
Detzel, G. E., Geo. E. Detzel Co., 2303 Gilbert Ave., Cincinnati, Ohio	1945
Devine, R. H., Asst. to Gen. Sls. Mgr., Koppers Co., Inc., 700 Koppers Bldg., Pittsburgh, Pa.	1953
Duffie, F. J., Serv. Engr., Linde Air Prod. Co., R. R. Dept., 230 No. Michigan Ave., Chicago 1, Ill.	1946
E	
Ehni, C. R., Prod. Engr., The Texas Co., 1130 Peronager Rd., Roanoke, Va.	1950
Eisenberg, A. H., Universal Engineering and Waterproofing Service, 82 Waverly Ave., Newark, N. J.	1953
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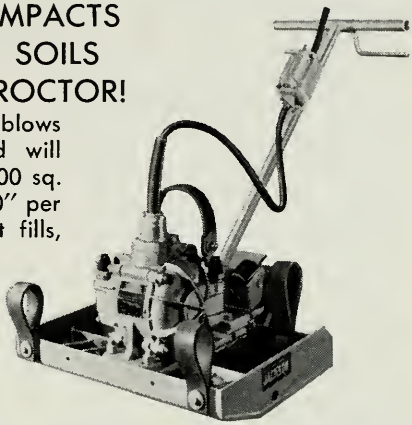

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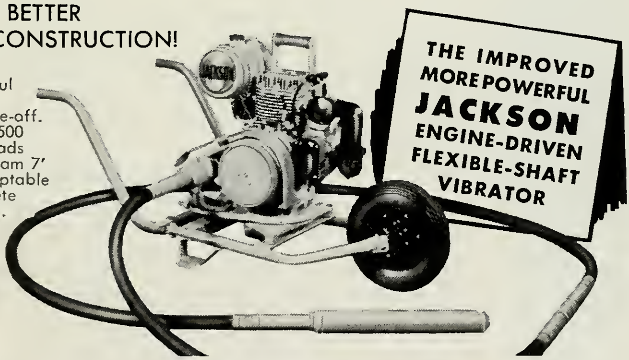

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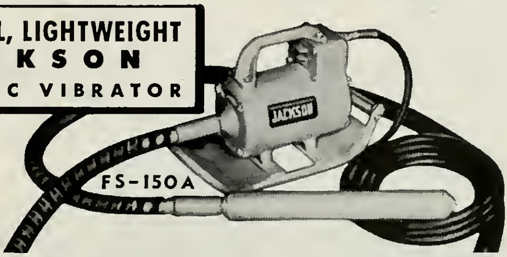

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Filkins, A. J., Pres., Filkins & Son, Co., 9 So. Clinton St., Chicago 6, Ill. 1927
Fix, F., Dist. Sls. Mgr., Transp. Dept., Johns-Manville Sls. Corp., 1530 Guildhall Bldg., Cleveland, Ohio 1946
Flannagan, L. F., Detroit Graphite Co., 7701 W. 47th St., Lyons, Ill. 1937
Fletcher, R. L., Struct. Engr., Timber Engineering Co., 1319 18th St., N. W., Washington, D. C. 1947
Flinn, L. E., Sls. & Serv. Repr., Dearborn Chemical Co., Merchandise Mart, Chicago, Ill. 1949
Forshee, R. E., Pres., R. E. Forshee Co., Inc., P. O. Box 416, Newtown, Ohio 1951
Fox, E. A., Dist. Mgr., The Master Bldrs. Co., 80 Boylston St., Boston, Mass. 1951
Frederick, H. Z., Mgr., Ry. Sls. Div., The R. C. Mahon Co., Detroit 34, Mich. 1950

G

Gaines, H. D., Sls. Engr., Lofland Steel Co., 1702 Stuart Ave., Houston, Tex. 1954
Gibboney, J. L., Vice Pres., Nat'l. Aluminate Corp., 422 No. Dover St., La Grange Park, Ill. 1949
Giles, J. M., Spl. Repr., Off-Track Equip., Caterpillar Tractor Co., Peoria 8, Ill. 1938
Glassgold, I. L., Pres., Masonry Resur. & Con. Co., Inc., B. & O. Coal Pier, Baltimore, Md. 1950

H

Hall, G. E. Jr., Sls. Repr., Johns-Manville Sls. Corp., 270 Madison Ave., New York 16, N. Y. 1951
Hansen, P. O., Mgr. R. R. Sls., Armco Drainage & Metal Prod. Inc., 1516 Keith Bldg., Cleveland 15, Ohio 1952
Harding, C. R., Pres., The Pullman Co., Merchandise Mart Plaza, Chicago, Ill. 1924
Hickey, J. F., Pres., Baker & Hickey Co., P. O. Box 5008, Tri-Village Sta., Columbus 12, Ohio 1946
Hoelzel, W. N., Gen. Mgr. Sls., Gary Screw & Bolt Div., Pittsburgh Screw & Bolt Corp., 122 So. Michigan Ave., Chicago 3, Ill. 1949
Hoffman, T. E., Div. Mgr. & Fire Prot. Supvr., Zone Co., 917 N. Main St., Ft. Worth, Tex. 1949
Holderman, H. L., Sls. Repr., Bird & Son, Inc., 203 S. West Ave., Elmhurst, Ill. 1951
Holmberg, V. V., Vice Pres., Ellington Miller, Contractors, 25 E. Jackson Blvd., Chicago 4, Ill. 1942
Holstein, F. W., Vice Pres., The Rails Co., 115 Observer Highway, Hoboken, N. J. 1948
Hopkins, W. S., Jr., M. of W. Rep., Air Reduction Sales Co., Garrett, Ind. 1949

J

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Kiester, R. S., Slsman., Pacific Coast Borax Co., 503 Southern Standard Bldg., Houston 2, Tex. 1950
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Kluiber, F. C., John Bean Div., Food Machine & Chemical Corp., Lansing, Mich. 1952

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LeDuc, C. L., Field Sls. Mgr., The Acorn Refining Co., Suite 1310 - 109 No. Wabash Ave., Chicago 2, Ill. 1946
Lee, R. H., Pres., Geo. Vang, Inc., 623 Grant Bldg., Pittsburgh 19, Pa. 1951
Littleton, E. J., Mgr. R. R. Sls., Jennison-Wright Corp., Granite City, Ill. 1949
Lockart, E. P., Sls. Mgr., Insulux Glass Block Div., Kimble Glass Co., P. O. Box 1035-36, Toledo, Ohio 1951
Luther, L. A., Serv. Engr., Ingersoll Rand Co., 1121 Hamilton Ave., Palo Alto Calif. 1945
Lynch, J. K., Asst. Res. Mgr., Massey Concrete Pro. Co., 3431 - 27th Ave., No. Birmingham, Ala. 1951
Lyon, C. A., Reg. Mgr., Master Builders Co., Rm. 412-414 Michigan Bldg., Detroit 26, Mich. 1945

Mc

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McFarland, M., Sls. Dept., E. I. Du Pont de Nemours Co., 1616 Walnut St., Philadelphia, Pa. 1952
McGehee, E. J., Vice Pres., Koppers Co., Inc., 122 So. Michigan Ave., Chicago 3, Ill. 1946
McMahon, R. D., Sales Engr., Fabreeka Prod. Co., 325 W. Huron St., Chicago, Ill. 1955

M

Mabry, D. B., Mgr. Lmbr. Sls., T. J. Moss Tie Co., 700 Security Bldg., St. Louis, Mo. 1948
Mann, E. A., Pres., Champion Transportation Sls., Inc., 222 W. Adams St., Chicago 6, Ill. 1951
Maurer, S. S., Western Div. Mgr., Fabreeka Prod. Co., 325 W. Huron St., Chicago 10, Ill. 1952
Mayfield, P. B., Tech. Cons., Barrett Div., Allied Chem. & Dye Corp., 40 Rector St., New York 6, N. Y. 1950
Mero, C. V., Mastercraft Tile & Roofing Co., No. 1 - 20th St., Richmond Calif. 1949
Montgomery, H., Dist. Mgr., The Master Builders Co., 2159 Bay St., Los Angeles, Calif. 1946
Myers, D. R., Sls. Repr., R. R. Sls., Patterson Sargent Co., 1882 S. Normal Ave., Chicago 16, Ill. 1952

N

Needham, L. H., Pres., The Penetryn System, Inc., 2294 Scranton Rd., Cleveland Ohio 1946

P

Patterson, R., Vice Pres., Intrusion Prepakt, Inc., 80 E. Jackson Blvd., Chicago 4, Ill. 1946
Patton, R. C., Tech. Adviser, Libby Zone Co., 731 E. Kingston Ave., Charlotte, N. C. 1952

R

Randle, F. R., Mgr. R. R. Sls., Hardesty Div., Armco Drainage & Metal Pro. Inc., P. O. Box 926, Salt Lake City, Utah 1954
Redding, G. H., Pres., Massey Concrete Prod. Co., 111 W. Washington, Chicago 2, Ill. 1946
Richter, R. W., Sls. Engr., Armco Drainage & Metal Products, 310 S. Michigan Ave., Chicago, Ill. 1953

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Ryan, P. H., Sls. Engr., Southern Amiesite Asphalt Co., P. O. Box 1390, Birmingham, Ala. 1952

S

Scott, J. M., Sls., The Arco Co., 614 Delaware St., Scranton 9, Pa. 1945
Seyler, A. P., Ind'l. Sls. Div., The Master Builders Co., 7016 Euclid Ave., Cleveland 3, Ohio 1954
Shoop, J. W., Vice Pres., The Lehon Company, 25th & Madison Ave., Bellwood, Ill. 1945
Smith, F. C., R. R. Dept., Marsh & McLennan, Inc., 231 S. LaSalle St. Chicago 4, Ill. 1948
Smith, W. T., Gen. Supt., Geo. E. Detzel Co., 2303 Gilbert Ave., Cincinnati, Ohio 1950
Snow, B. S., Pres., T. W. Snow Constr. Co., R. R. Supplies, 10 W. Wilson St., Batavia, Ill. 1946
Southwick, C. E., Factory Repr., Homelite Corp., 624 S. Anderson, Los Angeles 23, Calif. 1945
Spietz, W. P., Monarch Painting Serv., 5621 N. Glenwood Ave., Chicago 40, Ill. 1950
Stierer, G. W., Mgr. Struct'l. Steel Dept., Robt. W. Hunt. Co., 175 W. Jackson Blvd., Chicago 4, Ill. 1946
Sweitzer, R. W., Traf. Mgr., James Campbell Smith, Inc., 4057 Erie St., Willoughby, Ohio 1953

T

Thomas, P. E., Thomas Construction Engineers, 3300 Vanderbilt Rd., Birmingham, Ala. 1953
Thompson, N., Vice Pres., Homelite Corp., Port Chester, N. Y. 1946
Truss, F. W., Mgr. R. R. Sls., Armco Drainage & Metal Prod. Inc., 817 Ambassador Bldg., St. Louis 1, Mo. 1946

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Utley, O. H., Vice Pres., The Zone Co. A Div. - Southwestern Pet. Co., 917 N. Main St., Ft. Worth, Texas 1949

W

Walters, W. R., 1535 Rand Tower, Minneapolis, Minn. 1949
Wicker, W. S., Ch. Engr., Transportation Mutual Insurance Co., 150-10th Street, N.E., Atlanta 5, Ga. 1953
Williams, C. B., Pres., Ever Tight Bolt Assembly Co., 238 Lincoln Ave., Council Bluffs, Ia. 1954
Wilson, W. C., Sls. Engr., Ralph W. Payne Co., Nat'l. Met. Bk. Bldg., Washington D. C. 1951
Wingerson, C., R. R. Sls. Engr., Oliver Iron & Steel Corp., Henry W. Oliver Bldg., Pittsburgh 22, Pa. 1954
Winters, F. T., Jr., Mgr., Agricultural Sls. Div., Pacific Coast Borax Co., P. O. Box 9128, Station "S", Los Angeles 5, Calif. 1949

Y

Young, R. W., Jr., R. W. Young Mfg. Co., 20 No. Wacker Dr., Chicago 6, Ill. 1946

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1	St. Louis, Mo.	Sept. 25, 1891	60
2	Cincinnati, Ohio	Oct. 18-19, 1892	112
3	Philadelphia, Pa.	Oct. 17-19, 1893	128
4	Kansas City, Mo.	Oct. 16-18, 1894	115
5	New Orleans, La.	Oct. 15-16, 1895	122
6	Chicago, Ill.	Oct. 20-22, 1896	140
7	Denver, Colo.	Oct. 19-21, 1897	127
8	Richmond, Va.	Oct. 18-19, 1898	148
9	Detroit, Mich.	Oct. 17-19, 1899	148
10	St. Louis, Mo.	Oct. 16-18, 1900	143
11	Atlanta, Ga.	Oct. 15-17, 1901	171
12	Minneapolis, Minn.	Oct. 21-23, 1902	195
13	Quebec, Canada	Oct. 20-22, 1903	223
14	Chicago, Ill.	Oct. 18-20, 1904	293
15	Pittsburgh, Pa.	Oct. 17-19, 1905	313
16	Boston, Mass.	Oct. 16-18, 1906	340
17	Milwaukee, Wis.	Oct. 15-17, 1907	341
18	Washington, D. C.	Oct. 20-22, 1908	368
19	Jacksonville, Fla.	Oct. 19-21, 1909	393
20	Denver, Colo.	Oct. 18-20, 1910	428
21	St. Louis, Mo.	Oct. 17-19, 1911	499
22	Baltimore, Md.	Oct. 15-17, 1912	524
23	Montreal, Quebec	Oct. 21-23, 1913	570
24	Los Angeles, Cal.	Oct. 20-22, 1914	586
25	Detroit, Mich.	Oct. 19-21, 1915	665
26	New Orleans, La.	Oct. 17-19, 1916	710
27	Chicago, Ill.	Oct. 16-18, 1917	704
28	Chicago, Ill.	Oct. 15-17, 1918	716
29	Cleveland, Ohio	Oct. 21-23, 1919	776
30	Atlanta, Ga.	Oct. 26-28, 1920	840
31	New York, N.Y.	Oct. 18-20, 1921	850
32	Cincinnati, Ohio	Oct. 17-19, 1922	865
33	Seattle, Wash.	Oct. 16-18, 1923	846
34	Kansas City, Mo.	Oct. 21-23, 1924	837
35	Buffalo, N.Y.	Oct. 20-22, 1925	759
36	Richmond, Va.	Oct. 12-14, 1926	750
37	Minneapolis, Minn.	Oct. 18-20, 1927	754
38	Boston, Mass.	Oct. 23-25, 1928	755
39	New Orleans, La.	Oct. 15-17, 1929	755
40	Louisville, Ky.	Oct. 21-23, 1930	713
41	Chicago, Ill.	Oct. 16-18, 1934	592
42	Chicago, Ill.	Oct. 15-17, 1935	547
43	Chicago, Ill.	Oct. 20-22, 1936	588
44	Chicago, Ill.	Oct. 19-21, 1937	566
45	Chicago, Ill.	Oct. 18-20, 1938	589
46	Chicago, Ill.	Oct. 17-19, 1939	546
47	Chicago, Ill.	Oct. 15-17, 1940	610
48	Chicago, Ill.	Oct. 14-16, 1941	594
49	Chicago, Ill.	Oct. 20-22, 1942	618
50	Chicago, Ill.	Oct. 20-21, 1943	597
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56	Chicago, Ill.	Sept. 17-19, 1951	676
57	Chicago, Ill.	Sept. 15-17, 1952	667
58	Chicago, Ill.	Sept. 15-17, 1953	666
59	Chicago, Ill.	Sept. 13-15, 1954	682

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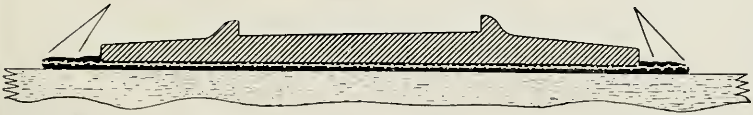

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